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ASSET EXEMPTION IN ENTREPRENEURS' BANKRUPTCY AND THE INFORMATIVE ROLE OF COLLATERAL

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ASSET EXEMPTION IN ENTREPRENEURS' BANKRUPTCY AND THE INFORMATIVE ROLE OF COLLATERAL*

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Abstract

If an entrepreneur files for bankruptcy under Chapter 7, (i) most of her debt is discharged, and (ii) only her non-exempt assets are liquidated. Entrepreneurs can undo this "insurance" by posting collateral. The opportunity cost of doing so is lower for safer entrepreneurs who face a lower probability of default. Accordingly, we show that under adverse selection, as exemption increases, collateral becomes a more effective sorting device. As a result, an entrepreneur's decision to post collateral improves access to credit and reduces the cost of credit to a greater extent the larger the exemption is. Econometric tests using data from the US Survey of Small Business support our theory.

Jel Codes: D82, E51, G33, K35

Keywords: Screening, Separation, Pooling, Exemption, Collateral, Credit rationing, Cost of credit

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1 Introduction

If an individual entrepreneur files for bankruptcy under Chapter 7, most of her (unsecured) debt is likely to be discharged. Moreover, only her non-exempt assets would be liquidated by the trustee appointed by the bankruptcy court to repay creditors.[1] Nevertheless, " [...] Although a debtor is not personally liable for discharged debts, a valid lien (i.e., a charge upon specific property to secure payment of a debt) that has not been voided (i.e., made unenforceable) in the bankruptcy case will remain after the bankruptcy case. Therefore, a secured creditor may enforce the lien to recover the property secured by the lien. [...]".[2] In other words, if debt is secured by a valid charge upon specific asset(s) (i.e., collateral), secured creditors can still enforce their rights and liquidate the asset(s).

That is, borrowers can undo the "insurance" effect of exemption and discharge by posting sufficient collateral; in doing so, they face an opportunity cost. In the event of default, a borrower who had offered assets as collateral would loose all of them, while she would have kept (at least some of) them (the exempt part) had she not offered them as collateral. This opportunity cost increases with the level of exemption, and it is equal to zero in the limiting case of no exemption, as in this case the entrepreneur would lose her assets (up to the value of the debt), independent of whether these are collateral. Importantly, when exemption is non-zero, this opportunity cost also varies across entrepreneur types. Specifically, it is lower for safe borrowers than for risky ones, as the former exhibit a lower probability of default than the latter. Accordingly, when asset exemption is different from zero, the decision to post collateral might play an informative role.

We show how taking this role of collateral into account results in a novel set of predictions about the role of exemption in the context of a standard competitive credit market characterised by adverse selection. In the model, entrepreneurs who are heterogeneous in both their individual chances of success and personal wealth demand a unit of credit each to finance their enterprises. Lenders, who

[1]According to the US Courts' official website, 99% of cases that are not dismissed or converted receive a discharge. Only non-exempt assets are liquidated by the trustee to repay creditors. According to the same source, in many cases, "[..] Chapter 7 cases are zero assets cases [..]". This anecdotal evidence suggests that the insurance effect implied by the combination of debt discharge and asset exemption could indeed be quite significant.

[2]This quote is taken from the following webpage of the official US federal courts' website: http://www.uscourts.gov/FederalCourts/Bankruptcy/BankruptcyBasics/DischargeInBankruptcy.aspx. As a clarifying example of the fact that exemption does not protect assets voluntarily posted as collateral, read about the case of Minnesota: http://www.legalconsumer.com/bankruptcy/bankruptcy-law.php?ST=MN. "[..] The investors who take the least risk are paid first. For example, secured creditors take less risk because the credit that they extend is usually backed by collateral, such as a mortgage or other assets of the company. They know they will get paid first if the company declares bankruptcy'[..]', http://www.sec.gov/investor/pubs/bankrupt.htm, U.S. Securities and Exchange Commission.

cannot observe entrepreneurs' riskiness, screen applicants by offering a menu of contracts that are possibly differentiated with respect to the following terms: (i) the probability of access to credit, (ii) collateral requirements, and (iii) the cost of credit. In the absence of asset exemption, pooling is the only equilibrium outcome, and no rationing takes place. In contrast, in the case of a non-zero exemption, the equilibrium always involves separation, at least for intermediate levels of entrepreneurial wealth. Safe entrepreneurs self-select into contracts characterised by effective collateral requirements, while risky entrepreneurs self-select into contracts that imply no collateral. Correspondingly, other things being equal, safe entrepreneurs face a lower cost of credit than risky entrepreneurs. As in Besanko and Thakor, 1987, separation is associated with rationing for safe entrepreneurs who are not wealthy enough to be able to meet the collateral requirements associated with lending contracts designed for safe borrowers and characterised by a probability of access to credit equal to one. When collateral cannot fully operate as a screening device, as borrowers are wealth-constrained, lenders separate potential borrowers using a combination of collateral requirements and the probability of being financed.

The key novelty of our analysis is that we are able to show how the equilibrium contracts, other things being equal, change with the level of exemption, which enables us to derive interesting implications in terms of the cost of and access to credit. For positive levels of exemption, we find that, conditional on posting collateral, as asset exemption increases, entrepreneurs' access to credit increases. In other words, entrepreneurs who separate by self-selecting into contracts characterised by higher collateral requirements face a lower probability of being rationed as the level of asset exemption increases. Similarly, other things being equal, as asset exemption increases, conditional on posting collateral, the cost of credit decreases. That is, collateral becomes a more powerful screening tool as the level of asset exemption increases. As a result, more separation occurs, in equilibrium, between safe and risky borrowers. Finally, the overall effect of an increase in asset exemption on credit rationing is uncertain. As asset exemption increases, safe entrepreneurs who separate by posting collateral face a lower probability of being rationed, which should reduce the level of credit rationing in the market. However, an increase in the level of asset exemption also increases the mass of safe entrepreneurs who decide to separate, thereby facing a lower probability of access to credit. The net result of these two contrasting effects is ambiguous and depends on the shape of the wealth distribution of the population of safe entrepreneurs.

We test the key implications of our model using US data from the Survey of Small Business Finances (SSBF) and exploiting the cross-state variability in exemption levels. There exists a broad empirical literature investigating the effects of asset exemption using these data. Relevant to our paper, Gropp et al., 1997, find that exemption reduces access to credit. Relatedly, Berkowitz and

White, 2004, find that high homestead exemption results in a greater chance of being denied credit and in a higher cost of credit for small businesses. Berger et al., 2011, who use the same wave of the survey as we do and introduce an individual-specific measure of asset exemption based on the comparison between individual home equity and homestead exemption, also find that exemption induces higher interest rates and lower access to credit.[3] These findings are also confirmed by our estimations. That is, higher exemption increases both the probability of credit rationing and the cost of credit.

More important, we contribute to the above empirical literature by using our theoretical model as an identification tool for the estimation to test key novel predictions about the joint effects of exemption and the decision to post collateral on access to credit and the cost of credit. In line with our model, what we find in the data is that while higher exemption and the decision to post collateral are, individually, negatively associated with access to credit, firms posting collateral are less likely to be rationed the higher the exemption level is. A similar conclusion holds for the cost of credit. The standard result is confirmed, that is, posting collateral causes a reduction in the cost of credit. Crucially, in line with the novel predictions from our model, we find this effect to be stronger the higher the level of exemption is. Overall, in line with Berger et al., 2011, our empirical findings offer support for the idea that the use of collateral reflects the presence of ex ante asymmetric information. These results are consistent with the idea of collateral being a signal of quality, which confirms what Jimenez et al., 2006, find for a sample of Spanish firms.

From a theoretical perspective, related to our paper, Manove et al., 2001, show that excessive creditor protection (i.e., too little asset exemption) might induce a lazy attitude among banks that forgo using their costly screening technology to assess borrowers. Complementary to that finding, our analysis highlights the fact that a reduction in the degree of creditor protection in the form of asset exemption gives lenders the incentive to screen applicants using collateral. Krasa et al., 2008, and Tamayo, 2015, study the effect of creditor protection on the cost of credit and probability of bankruptcy in a costly state verification environment. In these models, creditor protection is measured by the percentage of assets that firms retain in the event of bankruptcy. This is treated as exogenous, and therefore, the concept of creditor protection in these models differs from that implied by the bankruptcy exemptions associated with Chapter 7. As we show in our model, the effect of such exemptions can be undone by the decision to post collateral, which implies that the percentage of assets that a firm retains in the event of bankruptcy is – even in the presence of exemptions – endogenously determined.

Our model setup is borrowed from Besanko and Takor, 1987, with three important differences.

[3]Berkowitz and Lin, 2000, find an equivalent effect in the mortgage market, concerning access to credit.

First, we allow any value of exemption between zero and infinity, while they consider an economy where, in the event of default, creditors can satisfy their right to borrowers' assets only up to the level of collateral, a situation that corresponds to the case of 100% exemption in our setup. Second, in line with Hellwig, 1997, we model competition as a three-stage game. In stage one, the uniformed party (lenders) offers lending contracts; in stage two, borrowers apply for credit and choose among the contracts on offer; and in stage three, lenders can reject or accept any of the applications they receive. Introducing this third stage ensures the existence of a subgame perfect equilibrium. For any given level of entrepreneurial wealth, the equilibrium, whether separating or pooling, always delivers the contract most preferred by safe entrepreneurs.[4] Third, in our model, the credit market is populated by potential borrowers who are heterogenous in terms of wealth.

More broadly, our analysis also contributes to the vast literature on bankruptcy law and entrepreneurial activity. Elul and Gottardi, 2015, analyse the beneficial incentive effects that debt forgiveness (augmented by "forgetting" default) might have on entrepreneurial activity and welfare. Fan and White, 2003, show that if individuals are risk averse, asset exemption should increase their willingness to become entrepreneurs. Indeed, they estimate that the probability of owning a business is 35% for households living in states with unlimited exemption rather than low exemption. Akyol and Athreya, 2011, analyse the effects of bankruptcy exemption on individuals' attitudes toward to self-employment by examining the trade-off between the insurance and the cost of credit effects induced by higher exemption levels.

The paper is organised as follows. In sections 2 and 3, we present the model and its main results. In section 4, we develop the empirical analysis. Section 5 concludes the paper.

2 The model

We consider a competitive market populated by a large number E of entrepreneurs and a large number L of lenders. Both entrepreneurs and lenders are risk-neutral. The set of entrepreneurs, $\mathcal{E}$, and that of lenders, $\mathcal{L}$, are indexed by $e = 1, ..., E$, and $l = 1, ..., L$, respectively. Each entrepreneur is endowed with an investment opportunity of size equal to one and an amount of illiquid and pledgeable wealth, $w \in [\underline{w}, \overline{w}]$. $F(w)$ is the distribution of entrepreneurs with respect to w, where for any $w_1 \in [\underline{w}, \overline{w}]$ $F(w_1)$ is the fraction of entrepreneurs endowed with an amount of wealth $w \leq w_1$. For any given level of wealth, w, we define $\mathcal{E}_w \subseteq \mathcal{E}$ as the subset of entrepreneurs endowed with illiquid wealth w and $E(w) = |\mathcal{E}_w|$ as the corresponding number of entrepreneurs.

Entrepreneurs have no financial resources, meaning that they need to borrow to finance their

[4]See also Martin, 2009, 2008.

investments. Lenders are endowed with one unit of financial resources each and face an opportunity cost of capital, $r > 0$. With no loss of generality, we set $L/E > 1$, such that financial resources are abundant.

Each investment opportunity lasts one period and delivers $R > 0$ with probability p_θ and 0 otherwise, where p_θ is a function of the entrepreneur's type, $\theta = H, L$, with $p_H > p_L$. Accordingly, we use "type-H" and *safe* to refer to entrepreneurs of type-H and "type-L" and *risky* to refer to type-L entrepreneurs. We assume that $p_L R > (1+r)$, meaning that all entrepreneurs, irrespective of their type, are worth financing. Nature assigns an entrepreneur's type, θ, as follows. An entrepreneur is of type-H with probability μ and of type-L with probability $1 - \mu$.

Ex ante information about the wealth and type of individual entrepreneurs is private. However, ex post, wealth is observable and verifiable. Entrepreneurs can credibly disclose their wealth at no cost, ex ante.

2.1 ***Fresh start opportunity*** and the role of collateral

In the event of default, financed entrepreneurs fulfill their obligations with their own personal wealth. However, we assume that entrepreneurs are guaranteed a sort of fresh start opportunity by the bankruptcy law, in the following sense. If an entrepreneur endowed with an amount of wealth w defaults, lenders can appropriate his wealth only up to the non-exempt value,

$$w_\eta \equiv \max(w - \eta, 0) \tag{1}$$

where η is the amount of wealth exempted from liquidation and therefore not appropriable by lenders, as stated by the law. However, consistent with US personal bankruptcy law, we further assume that this exemption does not apply to wealth posted as collateral.

Finally, we assume that a unit of entrepreneurial wealth is worth $\beta < 1$ to the lenders, meaning that liquidating entrepreneurial wealth to repay external financing is inefficient.

2.2 Timing

The market functions as follows:

Stage 0 : Nature assigns entrepreneurial types.

Stage 1 : Lenders simultaneously offer credit contracts.

Stage 2 : Entrepreneurs decide whether to disclose information about their wealth and whether to apply for credit and under which contract.

Stage 3 : Lenders decide whether to reject or approve each loan application they receive.

Stage 4 : Exchange, if any, takes place.

2.3 Contracts

A lending contract $\mathcal{C}$ is defined as a triple, $\mathcal{C} = (R^B, C, \pi)$, where R^B is the cost of credit, C is the amount of collateral, and π is the probability of having access to credit. In the event of default, lenders are entitled to an amount of entrepreneurial wealth no greater than R^B/β, which would be as valuable to them as the value of the loans that they have issued, R^B. With that being given, and considering the level of asset exemption, η, the real guarantees implicitly offered by an entrepreneur endowed with wealth w if applying for the contract $\mathcal{C} = (R^B, C, \pi)$ amount to

$$G = \max(\min(w_\eta, \frac{R^B}{\beta}), C) \tag{2}$$

We note that, other things being equal, G is (weakly) increasing in C and (weakly) decreasing in η.

2.4 Agents' strategies and payoffs

The expected payoff of a type-θ entrepreneur who signs a generic contract, $\mathcal{C}$, is

$$u_\theta = \pi[p_\theta(R - R^B) - (1 - p_\theta)G] + w \tag{3}$$

Correspondingly, the expected payoff of a lender who finances that entrepreneur is

$$v_\theta = p_\theta R^B + (1 - p_\theta)\beta G \tag{4}$$

where we note that $u_H > u_L$ and $v_H > v_L$ hold.

2.5 The role of collateral as a screening device as a function of exemption, η

Let $\mathcal{C}_1$ and $\mathcal{C}_2$ be two contracts with $\pi_1 = \pi_2 = 1$, $C_1 > C_2$ and $R_1^B < R_2^B$, where we assume that the levels of guarantees associated with the two contracts, G_1 and G_2, satisfy $G_1 > G_2$.[5] Then,

$$p_L(R - R_1^B) - (1 - p_L)G_1 \geq p_L(R - R_2^B) - (1 - p_L)G_2 \tag{5}$$

[5]Note that, according to (2), $C_1 > C_2$ implies that $G_1 > G_2$ for η sufficiently high and β is sufficiently low, relative to the other parameter values.

implies that

$$p_H(R - R_1^B) - (1 - p_H)G_1 > p_H(R - R_2^B) - (1 - p_H)G_2 \tag{6}$$

This follows directly from $p_H > p_L$. That is, whenever a risky entrepreneur prefers the contract characterised by a higher level of real guarantees, a safe entrepreneur strictly prefers this contract. This sorting condition implies that type-H (type-L) entrepreneurs could self-select into contracts characterised by a level of guarantees that is comparatively high (low). Since guarantees are a weakly increasing function of collateral, this means that collateral has a potential role as sorting device.

As we shall see, the effectiveness of collateral as a signaling/sorting mechanism depends upon the level of exemption, η. The intuition is as follows. Under no exemption, i.e., if $\eta = 0$, entrepreneurs' wealth is liquidated independent of whether they post it as collateral. Hence, posting collateral does not provide any meaningful signal. In the opposite extreme case of unlimited exemption, i.e., if $\eta \to \infty$, entrepreneurs' wealth is liquidated in the event of default if and only if they post it as collateral, which implies that –to the extent that the above-described sorting condition holds– type-L entrepreneurs dislike posting collateral more than type-H entrepreneurs, and thus, the decision to post collateral plays a signaling role.

3 Equilibrium analysis

We focus on subgame perfect equilibria.[6]

Definition 1. *An equilibrium is a strategy profile for lenders and entrepreneurs such that at each node of the game, players' strategies for the remainder of the game are best replies given the strategies of the other players.*

We first characterise the possible separating and pooling equilibria and then study existence, thereby characterising the credit market equilibrium for any given level of entrepreneurial wealth, depending upon parameter values. With no loss of generality, we focus on parameter configurations such that the following holds.

Assumption 1 (Entrepreneurs' participation and loan riskiness)**.**

1. *For any level of guarantees, with $G \in [0, (1 + r)/\beta]$ implied by the equilibrium contract(s) available, both types of entrepreneurs are strictly willing to demand credit at a cost of credit that yields an expected return of $1 + r$ to the entrepreneurs.*

[6]These are equivalent to perfect Bayesian equilibria and sequential equilibria since the player who moves first has no private information, meaning that her beliefs are always determined.

2. *The non-exempt wealth of the richest entrepreneur,* $\overline{w}_\eta = \max(\overline{w} - \eta, 0)$*, is insufficient to repay the opportunity cost of credit,* $1 + r$*, in the event of default:*

$$\overline{w} < \frac{1+r}{\beta} + \eta \tag{7}$$

As we shall see, Condition 1 ensures that, in equilibrium, all entrepreneurs participate in the credit market. When characterising separating and pooling equilibria, we will state the explicit parameter restrictions necessary for this condition to hold. Condition 2, equation (7), states that even for the richest entrepreneur, the liquid value of non-exempt individual wealth, $\beta\overline{w}_\eta$, is lower than the lenders' opportunity cost of supplying credit, $1 + r$. Accordingly, as we shall see in equilibrium, loans are always risky.[7]

3.1 Separating equilibria

A separating equilibrium (SE) is a set of contracts,

$$\mathcal{C}^{SE} = \{\mathcal{C}_{\theta,w} = (R^B_{\theta,w}, G_{\theta,w}, \pi_{\theta,w}); R^B_{\theta,w} \geq 0, G_{\theta,w} \geq 0, w \in [\underline{w}, \overline{w}]; \theta = H, L\}$$

where $\mathcal{C}_{\theta,w}$ is the contract offered to a borrower of type-θ and wealth w, such that the following hold.

1. Borrowers' incentive constraints are satisfied:

$$(ICC_H) \;:\; \pi_{H,w}[p_H(R - R^B_{H,w}) - (1-p_H)G_{H,w}] \geq \pi_{L,w}[p_H(R - R^B_{L,w}) - (1-p_H)G_{L,w}] \tag{8}$$

$$(ICC_L) \;:\; \pi_{L,w}[p_L(R - R^B_{L,w}) - (1-p_L)G_{L,w}] \geq \pi_{H,w}[p_L(R - R^B_{H,w}) - (1-p_L)G_{H,w}] \tag{9}$$

2. Borrowers' participation constraints are satisfied:

$$(PC_H) \;:\; \pi_{H,w}[p_H(R - R^B_{H,w}) - (1-p_H)G_{H,w}] \geq 0 \tag{10}$$

$$(PC_L) \;:\; \pi_{L,w}[p_L(R - R^B_{L,w}) - (1-p_L)G_{L,w}] \geq 0 \tag{11}$$

3. Lenders' participation constraints (PCs) are satisfied:

$$p_\theta R^B_{\theta,w} + (1-p_\theta)G_{\theta,w}\beta \geq (1+r), \qquad \theta = H, L \tag{12}$$

4. Feasibility constraints are satisfied: $G_{\theta,w} \geq 0$, $G_{\theta,w} \leq w$, $\pi_{w,\theta} \in [0,1]0$, $\theta = H, L$.

[7] Clearly, if there were entrepreneurs with $\beta w_\eta \geq 1 + r$, given the opportunity cost of capital, $1 + r$, lending to these entrepreneurs would be safe, such that they would be offered credit at a cost $1 + r$, independent of their type. Assumption 1 rules out this uninteresting case with no loss of generality.

Thus, agents participate and entrepreneurs self-select into different contracts depending on their type. The following result holds.

Proposition 1 (SE: characterization). *The SE, if it exists, yields a unique outcome characterised by the fact that all entrepreneurs demand credit and lenders offer a menu of contracts, $\mathcal{C}^{SE} = \{\mathcal{C}_{\theta,w}\}$, where $\theta = H, L; w \in [\underline{w}, \overline{w}]$, with*

$$\begin{aligned} R^B_{\theta,w} &= \frac{(1+r)}{p_\theta} - \frac{(1-p_\theta)\beta G_{\theta,w}}{p_\theta} && (13) \\ G_{H,w} &= \min(\frac{(1+r)(p_H-p_L)+p_H(1-p_L)(1-\beta)G_{L,w}}{(1-p_L)p_H - p_L(1-p_H)\beta}), w) && (14) \\ G_{L,w} &= w_\eta && (15) \\ \pi_{L,w} &= 1 && (16) \\ \pi_{H,w} &= \min(\frac{p_L R - (1+r) - (1-p_L)(1-\beta)G_{L,w}]}{[p_L R - \frac{p_L}{p_H}(1+r) - (1-p_L)\left[1 - \frac{p_L}{p_H}\frac{1-p_H}{1-p_L}\beta\right] w}, 1) && (17) \end{aligned}$$

Proof. See appendix.

Figure 1 describes the levels of real guarantees, $G_{L,w}$ and $G_{H,w}$, associated with contracts $\mathcal{C}_{L,w}$ and $\mathcal{C}_{H,w}$ as functions of the level of wealth, w. Similarly, figures 2 and 3 describe the probabilities of being financed, $\pi_{H,w}$ and $\pi_{L.w}$, and the cost of credit, $R^B_{L,w}$ and $R^B_{H,w}$, associated with these contracts. Borrowers endowed with a value of wealth w such that $w > \widehat{w}$, where

$$\widehat{w} \equiv \begin{cases} \frac{(1+r)(p_H-p_L)-(1-p_L)(1-\beta)p_H\eta}{(p_H-p_L)\beta} & \text{if } \widehat{w} \in (\eta, \eta + \frac{(1+r)}{\beta}) \\ \frac{(1+r)[(p_H-p_L)+p_H(1-p_L)(1-\beta)\frac{1}{\beta}]}{(1-p_L)p_H - p_L(1-p_H)\beta} & \text{if } \widehat{w} \geq \eta + \frac{(1+r)}{\beta} \\ \frac{(1+r)(p_H-p_L)}{(1-p_L)p_H-(1-p_H)p_L\beta} & \text{if } \widehat{w} \leq \eta \end{cases} \qquad (18)$$

are *rich* in the sense that they can afford the level of real guarantees necessary to self-select into contracts designed for type-H borrowers and characterised by a probability of access to credit equal to one. In contrast, borrowers with $w < \widehat{w}$ are *poor*, as they cannot afford the level of real guarantees necessary to self-select into contracts for type-H borrowers that would assure full access to credit.[8] For any level of wealth, borrowers of type-H, who are safe, separate from type-L borrowers by self-selecting into contracts characterised by a higher level of guarantees and a lower (or equal) probability of access to credit than those associated with contracts for type-L borrowers. More precisely, rich type-H entrepreneurs are financed with probability one, while poor type-H entrepreneurs face a positive probability of rationing. For such borrowers, the marginal effect of an increase in wealth, w, on the probability of access to credit , $\pi_{H,w}$, is strictly positive. The poorer a safe entrepreneur is, the higher the probability of rationing (s)he faces if self-selecting into a contract designed for

[8]Note that there are three different expressions of $\widehat{w}$ depending on the parameter values.

safe borrowers (see figure 2).[9] Intuitively, lenders have two contractual instruments that they can use to separate safe from risky borrowers: collateral and the probability of access to credit. Poor entrepreneurs, who are already posting all their wealth as collateral, separate from risky borrowers by accepting a lower probability of access to credit. If their wealth were to increase, they could afford to offer more guarantees, such that there would be less need for lenders to use the probability of access to credit to separate these borrowers from risky borrowers. Finally, since conditional on wealth safe borrowers always post a higher level of guarantees than risky entrepreneurs (see figure 1), they always face a lower cost of credit (see figure 3).

3.1.1 Role of exemption

In an SE, the exemption level, η, affects guarantees, access to credit and the cost of credit as follows. As η increases, the level of guarantees offered by risky borrowers is reduced, such that the critical level of wealth, $\widehat{w}$, that a safe borrower needs to offer to be able to signal his type and be financed with probability one is also reduced (see figure 4). Correspondingly, a higher level of exemption results in a higher probability of having access to credit for safe borrowers at all levels of wealth, as shown in figure 5. Finally, conditional on wealth, the difference between the cost of credit faced by risky and safe borrowers is also increasing in the level of exemption (see figure 6).

3.2 Equilibrium selection and uniqueness of SE

The unique equilibrium outcome in terms of guarantees, the probability of access to credit and the cost of credit characterised in proposition 1 is associated with a unique equilibrium contract for type-H borrowers for any given level of wealth, w. The same is not true for type-L borrowers. For these borrowers, conditional on wealth, there is a continuum of contracts that are all characterised by the same cost of credit and probability of access to credit and different levels of C_L, with $C_L : C_L \leq w-\eta$, which all yield the same outcome in terms of guarantees. Therefore, strictly speaking, the SE defined in terms of collateral rather than guarantees is not unique. However, this is true if and only if borrowers incur no transaction (i.e., administrative) costs to post collateral. We know that in reality

[9] Given equation (17), the derivative of $\pi_{H,w}$ with respect to w yields

$$\frac{\partial \pi_{H,w}}{\partial w} = \begin{cases} \dfrac{\beta\left(Rp_L-(1+r)[p_L+\frac{1-p_L}{\beta}]\right)}{\{p_L R-\frac{p_L}{p_H}(1+r)-(1-p_L)\left[1-\frac{p_L}{p_H}\frac{1-p_H}{1-p_L}\beta\right]w\}^2} & \text{if } \widehat{w} \in (\eta, \eta+\frac{(1+r)}{\beta}) \\ \dfrac{[Rp_L-(1+r)](1-p_L)\left[1-\frac{p_L}{p_H}\frac{1-p_H}{1-p_L}\beta\right]}{\{p_L R-\frac{p_L}{p_H}(1+r)-(1-p_L)\left[1-\frac{p_L}{p_H}\frac{1-p_H}{1-p_L}\beta\right]w\}^2} & \text{if } \widehat{w} \leq \eta \end{cases} \quad (19)$$

which are always strictly positive provided that assumption 1 holds (see condition (A.32) in the appendix, which provides the explicit parameter restriction for assumption 1 to hold in an SE). Note that the second-order derivative is also positive.

such costs are always strictly positive. Accordingly, we select the SE equilibrium with $C_L = 0$ as the unique SE.[10]

3.3 Pooling equilibria

In any pooling equilibrium (PE), lenders offer a set of contracts, $\mathcal{C}^P = \{\mathcal{C}_w = (R_w^B, G_w, \pi_w); R_w^B \geq 0, G_w \geq 0, \pi_w \in [0,1]; w \in [\underline{w}, \overline{w}]\}$, where each contract is contingent on borrowers' wealth, w, such that the following hold.

1. Borrowers' participation constraints are satisfied:

$$(PC_H) \quad : \quad \pi_w[p_H(R - R_w^B) - (1-p_H)G_w] \geq 0 \tag{20}$$

$$(PC_L) \quad : \quad \pi_w[p_L(R - R_w^B) - (1-p_L)G_w] \geq 0 \tag{21}$$

2. Lenders make zero profits:

$$p_m R_w^B + (1-p_m)G_w\beta = (1+r) \tag{22}$$

where $p_m \equiv \mu p_H + (1-\mu)p_L$.

The following result holds.

Proposition 2 (PE: characterization). *The pooling equilibrium, if it exists, is characterised by the fact that all entrepreneurs demand credit and lenders offer the following set of contracts with positive probability:* $\mathcal{C}^P = \{\mathcal{C}_w^P = \{R_w^B, G_w, \pi_w\}, w \in [\underline{w}, \overline{w}]\}$, *where* $\pi_w = 1$, *and the following holds*

Case i. *If*

$$\beta\frac{1-p_m}{p_m} < \frac{1-p_H}{p_H} \tag{23}$$

then,

$$R_w^B = \frac{(1+r)}{p_m} - \frac{(1-p_m)}{p_m}\min(w_\eta, \frac{1+r}{\beta}) \tag{24}$$

$$G_w = \min(w_\eta, \frac{1+r}{\beta}) \tag{25}$$

Case ii. *If*

$$\beta\frac{1-p_m}{p_m} > \frac{1-p_H}{p_H} \tag{26}$$

[10] This corresponds to assuming that posting collateral entails a strictly positive cost, albeit negligible. An extension of potential interest, which we do not consider here to keep the analysis as simple as possible, would be to consider the role of such costs in shaping the role of collateral as a sorting device by assuming they are both positive and non negligible.

then,

$$R_w^B = \frac{(1+r)}{p_m} - \frac{(1-p_m)}{p_m}\min(w, \frac{1+r}{\beta}) \tag{27}$$
$$G_w = \min(w, \frac{1+r}{\beta}) \tag{28}$$

Case iii. *If*

$$\beta\frac{1-p_m}{p_m} = \frac{1-p_H}{p_H} \tag{29}$$

then, in general, there is a continuum of equilibrium values of $G_w \in [\min(w_\eta, \frac{1+r}{\beta}), \min(w, \frac{1+r}{\beta})]$*, and correspondingly, of the interest rate, where*

$$R_w = \frac{1+r}{p_m} - \frac{1-p_m}{p_m}\beta G_w \tag{30}$$

Proof. See appendix. In a pooling equilibrium, all entrepreneurs borrow under the same contract. No rationing takes place. The cost of credit is a decreasing function of wealth. Whether entrepreneurs post sufficient collateral in a pooling equilibrium to undo the effects of exemption depends upon whether safe entrepreneurs prefer to post collateral to obtain a lower cost of credit. Note that under perfect information, this would never happen, as repaying lenders by means of collateral is inefficient, given $\beta < 1$. However, under asymmetric information, if pooled with risky entrepreneurs, safe entrepreneurs – who are subsidising risky entrepreneurs – might actually prefer contracts characterised by higher collateral levels to reduce the cost of credit. In particular, this happens if and only if condition (26) holds, in which case the unique pooling equilibrium is characterised by the fact that all borrowers post an amount of collateral such that $G_w = \min(w, \frac{1+r}{\beta})$. Otherwise, if condition (23) holds, they would never choose to post enough collateral to undo the effects of exemption. Finally, in case iii, there exists a continuum of pooling equilibrium outcomes, whereby entrepreneurs are indifferent about the level of collateral to post.

3.3.1 Role of exemption in PE

Importantly, only if condition (23) holds, such that $G_w = \min(w_\eta, \frac{1+r}{\beta})$, is an increase in the level of exemption, η, associated with an increase in the cost of credit, as long as $w < \frac{1+r}{\beta}$ holds.[11] In no case does exemption affect access to credit.

[11]For obvious reasons, we disregard the special case iii, in which there exist a continuum of equilibrium values of collateral.

3.4 Credit market equilibrium

Having characterised the PE and SE, the task is now to characterise the credit market equilibrium for any given level of wealth. This involves studying whether, for any given level of wealth, separation or pooling takes place and under which conditions. Let w_1 and w_2 denote two critical levels of wealth, such that

$$(1+r)\frac{p_H - p_m}{p_m} = (1-\beta)(1-p_H)G_{H,w_1} + G_{H,w_1} p_H \left[\frac{1-p_H}{p_H} - \beta\frac{1-p_m}{p_m}\right] \quad (31)$$

$$\pi_{H,w_2}[p_H R - (1+r) - (1-p_H)(1-\beta)G_{H,w_2}] = p_H(R - \frac{(1+r)}{p_m}) - G_{H,w_2} p_H \left[\frac{1-p_H}{p_H} - \beta\frac{1-p_m}{p_m}\right] \quad (32)$$

where G_{H,w_1} and G_{H,w_2} are the values of the function $G_{H,w}$ as given by equation (14) for $w = w_1$ and $w = w_2$, respectively. The following result holds.

Proposition 3 (Credit market equilibrium). *In general, the credit market equilibrium is unique and characterised as follows:*

Case i. *If condition (23) holds, (1) all rich and safe entrepreneurs with $w < w_1$ separate from rich and risky entrepreneurs, while those with $w > w_1$ pool; (2) all safe and poor entrepreneurs with $w > w_2$ separate, while those with $w < w_2$ pool.*

Case ii. *If condition (26) holds, (1) separation occurs among rich entrepreneurs; (2) all safe and poor entrepreneurs with $w > w_2$ separate from risky entrepreneurs, while those with $w < w_2$ pool with risky entrepreneurs.*

For any given level of wealth, separating and pooling equilibrium contracts are those characterised by propositions 1 and 2, respectively.

Proof. See Appendix.

The intuition is as follows. According to proposition 2, whenever condition (26) holds, in equilibrium, any pooling contract would be characterised by maximum guarantees, i.e., by a level of guarantees equal to individual wealth, $G_w = w$. Clearly, rich and safe entrepreneurs would then strictly prefer the separating contract designed for them, which would be characterised by a lower level of guarantees[12] and a lower cost of credit. Therefore, under condition (26), rich and safe entrepreneurs never pool with risky entrepreneurs. The same argument would hold for poor and safe entrepreneurs, except that for these potential borrowers, the probability of being financed under a separating contract would be less than one and decline with w. Hence, there could be safe entrepreneurs who are sufficiently poor that they would be hardly financed if separating. This explains

[12]It is easy to verify that, for a rich entrepreneur, $G_{H,w} < w$. See, for instance, figure 1.

why, as long as $w_2 > \underline{w}$, there will be safe entrepreneurs who are poor enough, i.e., they have a level of wealth $w < w_2$, that they prefer to pool with risky borrowers rather than separate.

Conversely, according to proposition 2, in equilibrium, any pooling contract would be characterised by a level of guarantees equal to non-exempt wealth, $G_w = w - \eta$, as long as condition (23) holds. Therefore, in this case, rich and safe entrepreneurs could prefer to pool rather than to separate, as pooling involves less guarantees. However, this is not certain, as pooling entails a higher cost of credit.

As w increases, the first effect tends to dominate the second effect, meaning that, as long as $\overline{w} > w_1$ holds, there will be safe entrepreneurs who are rich enough, i.e., they are endowed with $w > w_1$, that they want to pool rather than to separate. Regarding poor entrepreneurs, the same argument as in the previous case holds, which implies that, as long as $w_2 > \underline{w}$, there will be safe entrepreneurs who are poor enough, i.e., they have a level of wealth $w < w_2$, that they prefer to pool rather than separate.

3.5 Empirical Implications: Cost of credit, access to credit and exemption

Given the characterization of the credit market equilibrium provided by propositions 1-3, the model delivers the following implications regarding the determinants of the cost of credit and access to credit, as well as for the role of exemption.

3.5.1 Cost of credit

First, independent of whether pooling or separation takes place, the cost of credit is negatively associated with entrepreneurial wealth. Second, as long as separation occurs, the cost of credit is negatively affected by the decision to post collateral. That is, conditional on wealth, type-H entrepreneurs, who post collateral, face a lower cost of credit than type-L entrepreneurs, who do not post any.

3.5.2 ii. Access to credit

To the extent that entrepreneurs pool, no rationing takes place. In contrast, when separation takes place, the possibility of equilibrium credit rationing emerges. Safe entrepreneurs are more likely to be rationed than risky entrepreneurs. Within the group of safe entrepreneurs, poorer entrepreneurs are more likely to be rationed than richer entrepreneurs. Moreover, the decision to post collateral is associated with a lower probability of accessing credit, as in equilibrium, only safe entrepreneurs, if any, are offered separating contracts with collateral requirements and the probability of accessing credit is lower than one. That is, as long as separation takes place, there is a negative relationship between posting collateral and access to credit, given sufficiently low levels of entrepreneurial wealth.

3.5.3 Effects of exemption on the access to and cost of credit

The level of exemption, η, affects the marginal effects induced by the various determinants of the cost of credit and access to credit, as follows. Regarding the cost of credit, as long as $w_\eta > 0$ holds, the higher η is, the larger is the cost of credit differential in favor of entrepreneurs of type-H, who are posting collateral, compared to type-L entrepreneurs, who do not post any collateral.[13] Regarding the effects of exemption on access to credit, our model predicts that rationing could only emerge with positive exemption. Furthermore, starting from positive exemption, an increase in exemption has uncertain effects on credit rationing. Two forces are at work. First, the higher η is, the greater the probability of having access to credit for each entrepreneur who separates by posting collateral.[14] This is because as the exemption level increases, the power of collateral as a sorting device is enhanced. Accordingly, higher levels of exemption are – other things being equal– associated with less rationing. However, as exemption increases, the threshold value of wealth, w_2, above which poor and safe entrepreneurs decide to separate rather than pool (see proposition 3) is reduced, meaning that more type-H entrepreneurs separate, thereby becoming rationed. Finally, this implies that the overall effect of exemption on credit rationing depends on how collateralisable wealth is distributed across entrepreneurs and is generally ambiguous.

[13] Calculating the difference between $R^B_{L,w}$ and $R^B_{H,w}$ and taking the derivative with respect to η yields

$$\frac{\partial(R^B_{L,w} - R^B_{H,w})}{\partial\eta} = -\frac{1-p_L}{p_L}\beta\frac{\partial G_{L,w}}{\partial\eta} + \frac{1-p_H}{p_H}\beta\frac{\partial G_{H,w}}{\partial G_{L,w}}\frac{\partial G_{L,w}}{\partial\eta} \tag{33}$$

We know that the derivative of $G_{L,w}$ with respect to η is zero if $w_\eta = 0$, which happens under sufficiently high (low) levels of η (w), and positive if $w_\eta > 0$, which is the case for sufficiently low (high) levels of η (w). Moreover, we know from the expression of $G_{H,w}$ that the derivative of $G_{H,w}$ with respect to $G_{L,w}$ is less than one. Hence, given $p_H > p_L$, the above derivative is zero when $w_\eta = 0$ and positive if $w_\eta > 0$.

[14] This effect is measured by

$$\frac{\partial\pi_{H,w}}{\partial\eta} = \frac{(1-p_L)(1-\beta)}{p_l R - \frac{p_L}{p_H}(1+r) - (1-p_L)\left[1 - \frac{p_L}{p_H}\frac{1-p_H}{1-p_L}\beta\right]w} > 0 \tag{34}$$

Note also that the cross derivative with respect to w is positive, such that the effect becomes more relevant as w increases.

4 Empirical analysis

We now turn to the empirical testing of the above implications. Specifically, our approach is to derive a structural and reduced-form econometric specification from the model to test its predictions about the effect of the decision to post collateral on (i) access to credit and (ii) the cost of credit, as well as about how such effects change with the level of exemption.

4.1 Data

We use the publicly available version of the 2003 wave of the Survey of Small Business Finances (SSBF), conducted in 2004-05 for the Board of Governors of the Federal Reserve System. This survey has been widely employed in the literature. Relevant to our analysis, Berger et al., 2011, and Berkowitz and White, 2004, both study the relationship between exemption and access to credit using the SSBF data.[15] The common data source improves the comparability of our findings and their empirical results. The data provide information on a sample of 4240 firms, selected from the target population of all for-profit, non-financial, non-farm, non-subsidiary business enterprises that had fewer than 500 employees and were in operation as of year-end 2003 and on the date of the interview. Information on the availability and use of credit and other financial services, demographic characteristics for up to three of the individual owners, and other firm characteristics such as number of workers, organizational form, location, credit history, income statement and balance sheet is available. The survey asked entrepreneurs whether their firm applied for credit during the last three years (from 2001 to 2003) and, if so, whether such applications were always denied, always approved or sometimes approved.[16]

Our estimation strategy is to adhere as closely as possible to the theoretical model, which we use as an identification tool. Accordingly, since in our model all firms are creditworthy, we restrict our sample to those firms that had loan applications approved at least once in the observation period.[17] By doing so, the sample size is reduced to 1761 creditworthy firms, 96% of which were always financed. For all these firms, which have been financed at least once in the period 2001 − 03, the survey provides

[15] Berger et al., 2011, combine various waves of the same survey over the period 1996-2005, while Berkowitz and White, 2004, use the 1993 wave.

[16] Note that the SSBF survey contains missing data. Most of missing variables have been originally imputed employing a randomised regression model. Accordingly, in our empirical analysis, we take into account the possible bias in the estimation arising from multiple imputations. A more detailed discussion of data imputation in the SSBF can be found in the 2003 Technical codebook available at http://www.federalreserve.gov/pubs/oss/oss3/ssbf03/codebook/codebook03.pdf

[17] We are fully aware that this might cause selection bias, and –as detailed below – we take that possibility into account in our econometric exercise.

some information on the most recent loan contract. In particular, we have information on the loan interest rate and whether the firm had to post some collateral to secure the loan.[18]

According to the model, only type-H firms post collateral. Accordingly, we use the decision to post collateral to identify a firm's type. Firms of type-H are those firms that, according to the data, are posting collateral, and firms of type-L those that are not. This is a crucial element of our identification strategy, as the model yields different predictions for these two types of firms.

4.1.1 Measures of exemption and entrepreneurial wealth

We augment the data by including the level of bankruptcy homestead and personal property exemptions according to firm's geographical location. Exemption levels vary across states. Unfortunately, however, the public version of the SSBF reports a firm's location only for nine census divisions (New England; Middle Atlantic; East North Central; West North Central; South Atlantic; East South Central; West South Central; Mountain; Pacific).

Thus, the best we can do is to exploit exemption variability across census divisions rather than states, where to each firm we assign the average level of exemption of its census division.

Determining the average level of exemption per census division is not trivial due to the presence of states with unlimited exemption. Fortunately, most of states in which exemption is unlimited concentrate in two of the nine census divisions. Accordingly, we construct a dummy variable that takes value one (high exemption) for firms located in these two (West North Central and West South Central) census divisions and zero (low exemption) otherwise.[19]

A firm's wealth is measured by its total assets. We divide firms into two groups. One includes firms with "high assets", that is asset values above the median, and the other includes those with "low assets", that is asset values below the median value. Thus, based on wealth and exemption, we ultimately have four categories of firms.

4.2 Descriptive statistics

Table 1 reports the descriptive statistics on the cost of credit and the probability of being rationed, both for the full sample and for the different subsamples defined above. The observed patterns are as follows:

[18] The dataset does not provide information on the amount of collateral posted.

[19] Alternatively, we could have computed the average exemption per census division by assigning each state with unlimited exemption a value of exemption equal to the average dollar value of the assets of firms located in the state's census division. Following this alternative procedure would deliver the same results as those we obtained.

1. High-asset firms face a lower cost of credit and a lower probability of being rationed. In this subsample of firms, the loan rate and the fraction of rationed firms are 1.5 and 3.8 percentage points lower than in the low asset group, respectively.

2. Firms posting collateral face a lower cost of credit. In the full sample, firms that post collateral are charged a loan rate that is 0.7 percentage points lower than that charged to other firms. Notably, this effect is larger the higher the exemption level is. In the low-exemption subsample, the cost of capital differential in favor of firms posting collateral is 0.53%, while that in the high-exemption subsample grows to 1.20%.

3. The correlation between the decision to post collateral and the cost of credit depends on wealth. Low-asset firms gain a reduction of 0.9 percentage points in the cost of capital if they post collateral, while for high-asset firms, the corresponding reduction is much smaller (0.04%).

4. Firms that post collateral are more rationed. The fraction of rationed firms among those that post collateral is 1.5 percentage points above the same value for those firms that do not post collateral.

5. The association between rationing and posting collateral depends on wealth. In the subsample of low-asset firms, the fraction of rationed firms is 4.4% higher for firms that post collateral compared to those that do not, while in the high-asset subsample, there is no difference in rationing depending on collateral.

6. Among firms posting collateral, the fraction of those that are rationed falls by 1.1% when moving from low to high exemption levels. This effect is larger (-1.9%) for low-asset firms compared to those with high assets (-0.5%).

Notably, the above evidence is entirely consistent with our model. In particular, (a) The loan rate differential in favor of firms posting collateral grows with exemption; (b) a smaller fraction of firms posting collateral is rationed in high-exemption census divisions than in low-exemption census divisions. We now proceed to test the model's key predictions.

4.3 Access to and cost of credit

We first discuss how we derive our econometric specifications for cost of credit and access to credit and then present the results.

4.3.1 Cost of credit

Our theory predicts that in a separating equilibrium type-H entrepreneurs – which are the only ones to post collateral – face a lower cost of credit. However, in the data, for the firms posting collateral (type-H), we only observe the cost of credit associated with this decision, R_H^B, while we do not observe the cost of credit that they would have paid had they not posted collateral, which we refer to as $R_L'^B$. Similarly, for firms not posting collateral (type-L), we only observe the cost of credit associated with that decision, R_L^B, while we do not observe the cost of credit that they would have faced had they posted collateral, $R_H'^B$. To circumvent this issue, we construct the counterfactual interest rates, $R_L'^B$ and $R_H'^B$, by means of an endogenous switching approach (Maddala, 1983), under the identifying assumption based on the model that the observed loan rates are determined by the entrepreneurial decision of whether to post collateral.

Accordingly, we model the observed loan rate for the two subsets of firms that self-select according to their collateral decision, $C = \{0, 1\}$, where 1 means "posting collateral" and 0 means "not posting collateral":

$$R_i^B|C = \mathbf{X_i}\beta + u_i \tag{35}$$

The endogenous switching approach allows us to account for firms' self-selection by 1. modeling the decision to post collateral and 2. linking the collateral decision to the cost of credit.

The decision to post collateral has the following empirical specification:

$$K_i^* = \mathbf{Z_i}\gamma + v_i \tag{36}$$

where K^* represents the net benefit of posting collateral, $\mathbf{Z}$ is a set of explanatory variables, γ is a vector of parameters, and v is the error term. Therefore, the decision of firm i to post collateral, C_i, is as follows:

$$C_i = \begin{cases} 1 & if \;\; \mathbf{Z_i}\gamma + v_i > 0 \\ 0 & if \;\; \mathbf{Z_i}\gamma + v_i \leq 0 \end{cases} \tag{37}$$

Regarding the observed interest rates, because of self-selection, we need to consider the latent variables that determine the decision to post collateral to correctly estimate equation (35). More precisely, given the self-selection model (37), assuming that u and v are bivariate normal, the expected value of $R_i^B|C$ is as follows:

$$E(R_{L,i}^B|C = 0) = \mathbf{X_i}\beta_{1_L} - \sigma_{1_{L,v}} \frac{\phi(-\mathbf{Z_i}\gamma)}{\Phi(-\mathbf{Z_i}\gamma)} \tag{38}$$

$$E(R_{H,i}^B|C = 1) = \mathbf{X_i}\beta_{1_H} + \sigma_{1_{H,v}} \frac{\phi(-\mathbf{Z_i}\gamma)}{1 - \Phi(-\mathbf{Z_i}\gamma)} \tag{39}$$

where ϕ is the pdf of the standard normal distribution, and Φ is the cumulative density function.[20] The functions $\lambda_{L,i} = -\frac{\phi(-\mathbf{Z_i}\gamma)}{\Phi(-\mathbf{Z_i}\gamma)}$ and $\lambda_{H,i} = \frac{\phi(-\mathbf{Z_i}\gamma)}{1-\Phi(-\mathbf{Z_i}\gamma)}$ are the inverse Mills ratios, and they represent the conditional expectation of v given the selection into not posting or posting collateral, respectively; that is, $\lambda = E(v_i|C)$.[21] Regarding the expected value of the unobserved interest rates, following Maddala, 1983, we have

$$E(R'^{B}_{L,i}|C = 0) = \mathbf{X_i}\beta_{2_H} - \sigma_{2_{H,v}} \frac{\phi(-\mathbf{Z_i}\gamma)}{\Phi(-\mathbf{Z_i}\gamma)} \tag{40}$$

which is the expected cost of credit faced by firms posting collateral (type-H) had they chosen not to post it, and

$$E(R'^{B}_{H,i}|C = 1) = \mathbf{X_i}\beta_{2_L} + \sigma_{2_{L,v}} \frac{\phi(-\mathbf{Z_i}\gamma)}{1 - \Phi(-\mathbf{Z_i}\gamma)} \tag{41}$$

which is the expected cost of credit for those not posting collateral (type-L) had they chosen to post collateral.

Accordingly, the estimation procedure is as follows. First, we obtain the appropriate inverse Mills ratios by estimating the selection process (equation 37) by means of the following probit specification:

$$C_i = \mathbf{Z_i}\gamma + v_i \tag{42}$$

where the linear predictions, $\mathbf{Z_i}\widehat{\gamma}$, that we obtain by estimating (42) are used to compute the estimated values of the inverse Mills ratios. Then, based on equations (38-41), we estimate the interest rates using an OLS specification. Then, for the subsample of type-L firms ($C = 0$), the expected loan rates are

$$\widehat{R}^{B}_{L,i} = \mathbf{X_i}\beta_{1_L} - \sigma_{1_{L,v}}\lambda_{L,i} \tag{43}$$

$$\widehat{R}'^{B}_{H,i} = \mathbf{X_i}\beta_{2_L} + \sigma_{2_{L,v}}\lambda_{H,i} \tag{44}$$

where $R'^{B}_{H,i}$ is the counterfactual interest rate. Similarly, for the subsample of type-H firms ($C = 1$), we have

$$\widehat{R}^{B}_{H,i} = \mathbf{X_i}\beta_{1_H} + \sigma_{1_{H,v}}\lambda_{H,i} \tag{45}$$

$$\widehat{R}'^{B}_{L,i} = \mathbf{X_i}\beta_{2_H} - \sigma_{2_{H,v}}\lambda_{L,i} \tag{46}$$

[20] The results of equation (38) follow due to the truncation of the distribution of R^B_L from above: $E(R^B_{L,i}|C = 0) = E(R^B_{L,i}|v_i \leq -\mathbf{Z_i}\gamma) = \mathbf{X_i}\beta_{1_L} + E(u_L|v_i \leq -\mathbf{Z_i}\gamma) = \mathbf{X_i}\beta_{1_L} - \sigma_{1_{L,v}}\frac{\phi(-\mathbf{Z_i}\gamma)}{\Phi(-\mathbf{Z_i}\gamma)}$. The results of equation (39) follow from the truncation of R^B_H from below: $E(R^B_{H,i}|C = 1) = E(R^B_{H,i}|v_i > -\mathbf{Z_i}\gamma) = \mathbf{X_i}\beta_{1_H} + E(u_H|v_i > -\mathbf{Z_i}\gamma) = \mathbf{X_i}\beta_{1_H} + \sigma_{1_{H,v}}\frac{\phi(-\mathbf{Z_i}\gamma)}{1-\Phi(-\mathbf{Z_i}\gamma)}$.

[21] Note that v_i is the part of K_i not explained by the observable information represented by the $\mathbf{Z_i}$ explanatory variables. In this sense, v_i is the private information that influences the decision of whether to post collateral. Ex ante, $E(v_i) = 0$, but ex-post, after the firm decides whether to post collateral, the expectation on v_i can be updated. $E(v_i|C)$ is the updated estimate of firm private information (Li and Prabhala, 2007).

Note that the model is identified by the non-linearity inherent in the inverse Mills ratio. In line with our theory, we expect that the estimated parameters are $\hat{\sigma}_{1_{L,v}} < 0$ and $\hat{\sigma}_{1_{H,v}} < 0$. That is, by posting collateral, a type-H firm self-selects into a contract designed for its type and pays a cost of credit that is below average. Conversely, firms that self-select into a contract without collateral pay a cost of credit that is above average.

This approach takes into account both the endogeneity arising from the simultaneous determination of the cost of credit and collateral and the role of private information implicit in the decision to post collateral.[22] According to our theory and as suggested by Li and Prabhala, 2007, in the self-selection model in equations (38)-(41), the decision to post collateral captures some unobserved heterogeneity about firm type. That is, by posting collateral, firms reveal private information about their type, which affects the cost of credit that they will face, through the parameters $\sigma_{1_{L,v}}$ and $\sigma_{1_{H,v}}$. In summary, we have the following:

1. the statistical significance of the coefficient associated with the inverse Mills ratio captures the self-selection effects associated with the choice of posting collateral;

2. the sign of the coefficient of the inverse Mills ratios identifies the benefit in terms of the cost of credit for those that post collateral compared to those that do not post it; and

3. the variables λ_L and λ_H are an estimate of the private information underlying firm choice, and the test of their significance is a test of whether private information possessed by the firm explains ex post results (cost of credit) (Li and Prabhala, 2007).

4.3.2 Access to credit

Based on our theoretical model, to the extent that safe entrepreneurs separate from risky entrepreneurs, the structural form equation for the equilibrium level of the probability of access to credit, π, is the following (see (16) and (17), proposition 1):

$$\pi = \begin{cases} \min\left(\frac{p_L(R-R^B_{L,w})-(1-\beta)w_\eta}{p_L(R-R'^B_{H,w})-(1-p_L)G_{H,w}}, 1\right) & \text{for type-}H\text{ firms} \\ 1 & \text{for type-}L\text{ firms} \end{cases} \tag{47}$$

where $R'^B_{H,w}$ is the (counterfactual) cost of credit that type-L firms would have paid had they posted collateral. In contrast, to the extent that heterogeneous entrepreneurs pool together, $\pi = 1$ holds (see proposition 2). Accordingly, the probability of access to credit is i. (weakly) decreasing as we move from firms of type-L to firms of type-H, as only poor firms of type-H are rationed, if any; ii.

[22] An alternative approach to account for this endogeneity is to estimate a simultaneous model of joint determination of collateral and the cost of credit. We employ this alternative approach as a robustness check in section 4.4.

increasing in the level of entrepreneurial wealth; and iii. decreasing in the cost of credit. Moreover, the effect associated with a firm's type is declining with exemption, as type-H firms are less rationed the higher the level of exemption is. Importantly, according to the model, both the cost of credit and a firm's type are exogenous with respect to the probability of having access to credit. Accordingly, we specify the following econometric model for the probability of of firm i having access to credit:

$$\pi_i = \alpha_1 \mathbf{Y_i} + \alpha_2 \eta_i + \alpha_3 C_i + \alpha_4 C_i \times \eta_i + \alpha_5 \frac{R^B_{L,i}}{R'^B_{H,i}} + u_i \tag{48}$$

where π_i takes two values, 1 if firm's loan applications have always been approved and 0 if they have only sometimes been approved; $\mathbf{Y_i}$ is a set of controls that affect a bank's decision to supply credit; $\boldsymbol{\alpha_1}$ is a vector of parameters; α_2, α_3, α_4 are parameters; η_i is a dummy that equals one if the firm is located in a census division with high exemption; C_i is a dummy that equals one if firm i posts collateral; $C_i \times \eta_i$ is an interaction term; and $u_i \sim N(0, \sigma_1)$ is the error term. We estimate equation (48) by probit.

Following our theoretical model, the variable C_i captures a firm's type, as only type-H firms post collateral, while the interaction term captures the model's prediction according to which access to credit should improve for firms of type-H (which are the firms posting collateral) compared to firms of type-L as exemption increases. The variables R^B_L and R'^B_H are proxied by the predicted values resulting form the estimation of equations (43)-(44). In line with the theoretical model (equation 47), we include the ratio between the actual and the counterfactual rates for type-L in equation (48). This ratio can also be viewed as an indicator of the relevance of the private information revealed by the decision to not post collateral. Our estimation differs from the model estimated in Berkowitz and White, 2004, as we take into account the simultaneity of the cost of credit and collateral decisions, as well as the extent of private information in access to credit. According to our theory, we expect $\hat{\alpha}_3 < 0$, $\hat{\alpha}_4 > 0$ and $\hat{\alpha}_5 < 0$.

4.3.3 Control variables

The set of controls $\mathbf{X_i}$, $\mathbf{Z_i}$ and $\mathbf{Y_i}$ in models (42)-(46), and (48) contains variables related to a number of firm characteristics that have been found to have a significant impact either on the probability of accessing credit, the cost of credit or both in the empirical literature.

Sorensen and Chang, 2006, provide substantial evidence of a positive relationship between an entrepreneur's experience and the firm's profitability. To capture an entrepreneur's experience, we include the number of years of managerial experience held by the principal owner.

Belonging to a minority group has been found to reduce the probability of obtaining a loan (Cavalluzo and Wolken, 2005; Berkowitz and White, 2002), while Cerqueiro and Penas, 2011, find evidence that owners belonging to a minority group rely more heavily on their own funds to finance a startup. We control for minorities by means of two dummies. The first takes value 1 if the principal owner is black and 0 otherwise. The second takes value 1 if the owner belongs to other minority groups (asian, hispanic, asian pacific, native american) and 0 otherwise. We also include a dummy indicating whether the owner is female, to assess possible discrimination effects on the cost of credit. A firm's proprietorship characteristics may affect access to and the cost to credit, as family ownership may reduce agency costs and promote trust. Anderson et al., 2003, suggest that if families tend to maintain a favorable reputation with the firm's debt holders, we should observe a negative relationship between family proprietorship and the cost of credit. Niskanen et al., 2010, find evidence that for small Finnish firms, family ownership is associated with lower availability of credit, while managerial ownership leads to lower collateral requirements.[23]

The firm-bank relationship can be represented by several variables, such as the firm's distance from the bank and the length of the relationship with the lender. The structure of local credit markets may also have a role in explaining the cost of credit. To account for banks local market power, we include a dummy that is equal one if the Herfindahl-Hirschman bank deposit index of local credit market concentration is greater than 1800.[24] We also include the number of credit applications in the previous three years as a proxy for a firm's financial needs.[25] To control for a borrower's observable quality, we include a dummy that is equal to one if the firm's credit score is in the top 25% of the distribution.

We also account for the fact that the cost of the loan might be affected by loan characteristics. Accordingly, we distinguish two typologies: 1. line of credit and 2. fixed interest rate loans.

We control for firm's scale using the log of sales, and we use the ratio of debt to total assets as a measure of a firm's financial structure, i.e., the firm's leverage. Finally, as mentioned above, a firm's wealth is proxied by its assets.

In the estimation of the decision to post collateral (equation (42)), we employ as controls the dummy for high credit score (top 25%), loan maturity, the amount granted over the total amount applied for, bank market concentration, a dummy for limited liability, a dummy for a female applicant, the length of firm-bank relationships, and the dummy for family proprietorship.

In the equation for the probability of access to credit (equation (48)), the control variables are mainly related to loan characteristics and firm-bank relationships. We consider the amount of funds

[23] They suggest that family ownership increases agency costs, which the bank accounts for when dealing with such firms.

[24] In the public version of the SSBF, bank market concentration is reported in three classes: Herfindahl index below 1000, between 1000 and 1800, and above 1800.

[25] Frequent loan applications may be a signal of either financial distress or greater investment opportunities.

granted over the total amount requested. Larger loans, given other firm and loan characteristics, increase bank profits and hence the bank's willingness to finance. We also include loan maturity, which we expect to have a negative effect on the probability of having access to credit, as long-term loans could be less liquid and therefore more risky from the bank's perspective. A longer firm-bank relationship improves the information flow between lenders and borrowers. We include the numbers of years of the relationship with the lender, and we expect it to have a positive effect on the probability of receiving a loan. Past delinquencies may represent a bad signal regarding firm trustworthiness. Thus, we expect a negative sign for the dummy that equals one if the firm has a delinquency record. As in the loan rate equation, we include a firm's credit score to proxy for its credit quality. We also control for a firm's capital structure. The ratio of debt to total assets is expected to have a negative impact on the bank's willingness to finance because higher leverage may reduce the firm's ability to repay. A firm's wealth, as proxied by its assets, is expected to have a positive effect on the probability of having access to credit. Finally, we include a dummy that is equal to one if the firm has limited liability, which might limit banks' ability to seize owners' wealth in the event of default.

4.3.4 Results

In table 3, we report the estimation of the expected cost of credit. Our results show that the private information conveyed by the collateral decision is relevant. As predicted by the model, the coefficients of the inverse Mills ratios are negative and significant. The negative signs of the coefficients of λ_H and λ_L imply that there is a negative correlation between the unexplained factors that affect the cost of credit and those that affect the decision to post collateral. This means that, other things being equal, the decision to post collateral implies a lower cost of credit. The firms that post collateral have a below-average cost of credit regardless of whether they post collateral but are better off posting than not posting. In addition, it is worth noting that the estimated $\hat{\sigma}_{1L,v}$ is the double of $\hat{\sigma}_{1H,v}$, meaning that safe firms choose contracts involving an expected cost of credit with lower variance.

As predicted in the model (equation 13), an increase in exemption raises the cost of credit, R_L^B, for those firms not posting collateral, while the opposite is the case for firms posting collateral. The cost of credit faced by these firms, R_H^B, decreases with exemption.

Finally, an increase in wealth (as proxied by the level of firm assets) reduces the cost of credit for firms not posting collateral, R_L^B, but only in high-exemption areas. Wealth also reduces the cost of credit for borrowers posting collateral, R_H^B, but not in high-exemption areas: In these areas, we find no significant effect of wealth on R_H^B. This is consistent with our theory, according to which firms could undo the effect of exemption by posting collateral. In summary, the above results are consistent with our model because

i. the collateral decision conveys private information about firm type;

ii. posting collateral involves a lower cost of credit in high-exemption areas; and

iii. exemption is negatively correlated with the cost of credit faced by firms posting collateral, R_H^B, and positively correlated with the cost of credit of firms not posting collateral, R_L^B.

In table 4, we report the results of the estimation of model (48) for the probability of having access to credit. In column 2, we report the estimation results obtained when employing an estimation method that accounts for the possible bias due to the fact that the SSBF dataset is imputed.[26] The procedure increases the variance of the parameters and may result in a reduction of their statistical significance.

A firm's type, as proxied by the decision to post collateral, C_i, and the interaction term between the decision to post collateral and the high exemption dummy are highly significant and with the expected sign. Posting collateral is positively associated with rationing. However, firms that post collateral are less likely to be rationed if they are located in a census division with high exemption. Consistent with our theoretical model, an increase in the cost of credit faced by firms posting collateral increases their probability of having access to credit. Conversely, an increase in the cost of credit faced by firms not posting collateral reduces the probability that firms posting it will have access to credit.

To shed light on the interaction effects between posting collateral and exemption, in table 5, we report the adjusted predictions of the probability of receiving a loan for all possible combinations of the two dummies. Consistent with the model, we observe the following. First, on average, posting collateral is associated with a reduction in the probability of having access to credit by 0.6%. Second, in areas with high exemption, posting collateral increases the probability of having access to credit by 1.5%.

In the light of these estimates, we conclude that the main predictions of the model regarding access to credit, the cost of credit, the decision to post collateral and exemption cannot be rejected. Our results complement those found in the literature. Similar to Gropp et al., 1997, Berkowitz and White, 2004, and Berger et al., 2011, we find a positive association between (i) exemption and rationing and (ii) exemption and the cost of credit. Our contribution is to show that according to the data, while the effect of high exemption is to increase credit rationing, the interaction between collateral and exemption tells us that, conditional on posting collateral, rationing is comparatively lower in

[26] In particular, following Rubin, 1987, we adopt an estimation procedure that computes estimates of coefficients and standard errors by applying combination rules to the individual estimates obtained by each imputation. This is implemented in STATA by means of the `mi estimate` command.

high-exemption areas. That is, we cannot reject our model's hypothesis that posting collateral should be associated with a reduction in the probability of being rationed as exemption increases, due to the enhanced power of the decision to post collateral as a sorting device. Similarly, we show that the negative effect of the decision to post collateral on the cost of credit grows in magnitude with the level of exemption. The evidence is thus consistent with the fact that collateral plays a role as a screening device and is a signal of quality, as in Jimenez et al., 2006.

4.4 Robustness

4.4.1 Relationship among collateral, exemption and cost of credit

The empirical predictions of our theoretical model for the impact of the decision to post collateral on the cost of credit, depending on the level of exemption, can also be tested using a reduced-form equation. The model is the following:

$$R_i^B = \boldsymbol{\beta_1}\mathbf{X_i} + \beta_2\eta_i + \beta_3 C_i + \beta_4 C_i\eta_i + v_i \tag{49}$$

where $\mathbf{X_i}$ is a set of controls; $\boldsymbol{\beta_1}$ is a vector of parameters; η_i is a dummy that equals one if a firm is located in a census division with high exemption; C_i is a dummy that equals one if firm i posts collateral; $C_i \times \eta_i$ is an interaction term; β_2, β_3, β_4 are parameters; and $v_i \sim N(0, \sigma_2)$ is the error term. We estimate the loan rate equation by OLS.

Our theory predicts that type-H firms – which are the only firms to post collateral – face a lower cost of credit. Hence, we expect that $\hat{\beta}_3 < 0$. Furthermore, the cost of credit differential in favor of firms of type-H should increase with exemption, such that we expect that $\hat{\beta}_4 < 0$. Finally, we expect that $\hat{\beta}_2 > 0$, as our theory predicts that the interest rate increases in exemption for type-L firms that are not posting collateral.

The OLS estimation of the cost of credit regression model (49) is reported in column (1) of table 6, while in column (2), we report the estimation considering the data imputation of SSBF dataset. Both the coefficient for firm type, as identified by the decision to post collateral, C_i, and that for the interaction term between the decision to post collateral and the high exemption dummy, remain significant and maintain the expected sign. Therefore, we conclude that, in line with the predictions from the theoretical model, the evidence is that firms posting collateral face a lower cost of credit, and this effect is larger the greater the level of exemption is. On average, firms posting collateral pay 0.30% less per unit of loans compared to firms that do not post collateral. Moving from a state with low exemption to a state with high exemption, posting collateral increases the discount by a 0.55%. All control variables have the expected sign, although they are not always significant in both estimations.

4.4.2 Simultaneous structural relationship between cost of credit and guarantees

According to the model, the equilibrium levels of firm guarantees conditional on the entrepreneur's type, G_L, and G_H, and the corresponding values of the cost of credit, R^B_H, and R^B_L – none of which are affected by the probability of having access to credit – are simultaneously determined. Therefore, for robustness, we also estimate a system of two equations for the cost of credit as a function of the guarantees and the amount of guarantees as a function of the cost of credit. Details on the estimation methodology are reported in the appendix, part B.

The estimation results (table 7) show a negative relationship between R^B and G. Other things being equal, posting guarantees is associated with an average reduction in the cost of credit of 34 basis points. For the subsamples of the firms located in groups of states with high exemption levels, the reduction in the cost of credit associated with posting guarantees is three times larger than that for firms located in low-exemption states (75 vs 17 basis points). This result is again in line with model predictions and confirms the evidence found from the other empirical tests.

4.4.3 Selection

As mentioned above, since in the theoretical model, all entrepreneurs are creditworthy, we conduct our empirical analysis on the subsample of firms that needed credit and have been financed at least once. This leads to the possibility of sample selection bias. In particular, we may assume that the selection process depicted in figure 7 applies, as follows.

> Stage 1: decide whether to apply for a bank loan.
>
> Stage 2: Of the firms applying for a loan, a subset of is not creditworthy; this is the subsample of firms that are always rejected.
>
> Stage 3: Among creditworthy firms, some are always financed and some are financed only sometimes.

To the extent that firms applying for credit and creditworthy firms are selected subsamples, our estimates might suffer from selection bias. We control for this possibility by estimating a selection model à la Heckman. Notably, controlling for selectivity does not alter any of our conclusions.[27]

[27] Estimation details are presented in appendix, section C, which is not meant for publication, and would be available on request.

5 Conclusion

According to US bankruptcy law, under Chapter 7, entrepreneurs benefit from an "insurance effect" because various types of debt are discharged, and moreover, only non-exempt assets are liquidated by the trustee appointed by the bankruptcy court to repay creditors. According to our theoretical analysis, the fact that entrepreneurs can undo this insurance effect by posting sufficient collateral implies that the level of asset exemption has significant consequences for the functioning of the credit market, in terms of access to and the cost of credit. We find that positive exemption levels lead to lower access to credit and a higher cost of credit. However, as the level of asset exemption increases, the probability of having access to credit for those entrepreneurs who signal that they are of the safe type by self-selecting into contracts characterised by relatively higher collateral requirements is enhanced. Furthermore, the decision to post collateral results in a greater reduction in the cost of credit the higher the level of exemption is. As we show, these effects are due to the fact that as exemption increases, the opportunity cost of posting collateral also increases, which makes collateral a more effective signaling/sorting device. The consequences of an increase in the level of exemption for overall credit rationing are ambiguous. Safe entrepreneurs posting collateral face a lower probability of being rationed, which should reduce overall credit rationing; however, more safe entrepreneurs self-select into contracts characterised by higher collateral requirements and a lower probability of having access to credit as exemption increases, which should increase it. The net trade-off between these two opposing effects depends on the shape of the wealth distribution across entrepreneurs and is generally ambiguous. The empirical tests we perform based on the SSBF data indicate that we cannot reject any of the main predictions of the model concerning the effect of asset exemption on access to and the cost of credit.

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A Appendix

A.1 Proof of proposition 1

We provide a full characterization of SE under the assumption that entrepreneurs decide to disclose their wealth when borrowing. Later (see section A.4), we prove that this is indeed the case.

i. Cost of credit. The following (preliminary) result holds:

Lemma 1. *In any equilibrium, lenders must be making zero profits.*

Proof. Consider a candidate equilibrium E whereby, for each level of wealth, $w \in [\underline{w}, \overline{w}]$, lenders offer $\mathcal{C}_{L,w} = \left(R^B_{L,w}, G_{L,w}, \pi_{L,w}\right)$ and $\mathcal{C}_{H,w} = \left(R^B_{H,w}, G_{H,w}, \pi_{H,w}\right)$, to risky and safe borrowers, respectively, and make strictly positive profits.[28] Since financial resources are abundant, the probability of financing an entrepreneur must be less than one for at least some of the lenders. Any of these lenders would be strictly better off by deviating and offering a contract $\mathcal{C}'_{L,w}$ to type-L borrowers, characterised by $R^{B'}_{L,w} = R^B_{L,w} - \epsilon$, with $\epsilon > 0$. Such a contract will attract all type-L borrowers – and potentially also type-H borrowers (which are safer and therefore of better quality from the lenders' perspective), and it would guarantee the lender an expected profit strictly greater than the equilibrium profit for ϵ sufficiently small, as the lender would now be able to finance an entrepreneur with probability one. Therefore, in any equilibrium, lenders must be making zero profits.□

According to the above lemma, in any SE, lenders' PCs are satisfied as strict equalities:

$$p_H R^B_{H,w} + (1-p_H)G_{H,w}\beta = (1+r) \Rightarrow R^B_{H,w} = \frac{(1+r)}{p_H} - \frac{(1-p_H)\beta G_{H,w}}{p_H} \tag{A.1}$$

$$p_L R^B_{L,w} + (1-p_L)\beta G_{L,w} = (1+r) \Rightarrow R^B_{L,w} = \frac{1+r}{p_L} - \frac{(1-p_L)\beta G_{L,w}}{p_L} \tag{A.2}$$

This also implies that financed entrepreneurs make strictly positive profits, as they appropriate all the expected surplus.

ii. Guarantees, collateral and access to credit for type-L borrowers. Because $\beta < 1$, asset liquidation is an inefficient way for entrepreneurs to transmit cash flows to lenders. Consequently, in any SE equilibrium, the level of guarantees associated with the contract designed for type-L

[28] For any given level of wealth, $w \in [0, \overline{w}]$, the candidate equilibrium involves pooling if $\mathcal{C}_{L,w} = \mathcal{C}_{H,w}$ and a separation otherwise.

entrepreneurs should be minimised. If not, it is immediate to verify that there always exists a strictly profitable deviation for lenders, which would be to offer a contract $\mathcal{C}'_{L,w}$ to type-L borrowers, characterised by $R^{B'}_{L,w} = R^{B}_{L,w} + \epsilon$, with $\epsilon > 0$, and $G'_{L,w} < G_{L,w}$, where $G_{L,w}$ is the level of guarantees associated with the equilibrium contract designed for type-L entrepreneurs, which simultaneously makes both lenders and type-L entrepreneurs strictly better off, given ϵ small enough. Accordingly, given assumption 1,

$$G_{L,w} = w_{\eta} \tag{A.3}$$

must hold, which means that the level of collateral associated with the contract designed for type-L entrepreneurs, $C_{L,w}$, satisfies $C_{L,w} \leq G_{L,w}$.

Regarding the probability of having access to credit, $\pi_{L,w}$, consider a candidate SE in which lenders are making zero profits and $\pi_{L,w} < 1$. Clearly, lenders have a strictly profitable deviation, which is to offer $\mathcal{C}'_{L,w} = \{R^{B}_{L,w} + \epsilon, G_{L,w}, 1\}$, where we note that such a deviation will surely attract at least entrepreneurs of type-L as long as $\epsilon > 0$ is sufficiently small. Hence, in any equilibrium, $\pi_{L,w} = 1$. In summary, type-L entrepreneurs obtain the same contract they would have obtained under perfect information (no distortion at the bottom).

iii. Guarantees, collateral and access to credit for type-H borrowers. Given the equilibrium values for $R^{B}_{H,w}$, $R^{B}_{L,w}$, and $\pi_{L,w}$, the corresponding equilibrium values for $\pi_{H,w}$ and $G_{H,w}$ are found by solving the following maximization problem:[29]

$$\max_{\{\pi_{H,w}, G_{H,w}\}} \pi_{H,w} \left[p_H R - (1+r) - (1-p_H)(1-\beta) G_{H,w}\right] + w \tag{A.4}$$

[29]Note that we use (A.1) and (A.2) to substitute for the equilibrium values of $R^{B}_{H,w}$ and $R^{B}_{L,w}$ as functions of $G_{H,w}$ in the objective function and in the constraints.

subject to

$$\pi_{H,w}\left[p_H R-(1+r)-(1-p_H)(1-\beta)G_{H,w}\right]-$$
$$\{p_H\left(R-\frac{1+r}{p_L}\right)-G_{L,w}\left[1-p_H-\frac{p_H}{p_L}(1-p_L)\beta\right]\}\geq 0 \tag{A.5}$$
$$\left[p_L R-(1+r)-(1-p_L)(1-\beta)G_{L,w}\right]-$$
$$\pi_{H,w}\left[p_L(R-\frac{1+r}{p_H})-G_{H,w}\left[(1-p_L)-\frac{p_L}{p_H}\beta(1-p_H)\right]\right]\geq 0 \tag{A.6}$$
$$\pi_{H,w}\geq 0 \tag{A.7}$$
$$1-\pi_{H,w}\geq 0 \tag{A.8}$$
$$G_{H,w}-w_\eta\geq 0 \tag{A.9}$$
$$w-G_{H,w}\geq 0 \tag{A.10}$$

The Lagrangian expression associated with the above problem is

$$\begin{aligned}
\mathcal{L} &= u_H+\overline{\lambda}_\pi(1-\pi_{H,w})+\underline{\lambda}_\pi\pi_{H,w}+\overline{\lambda}_G\left[w-G_{H,w}\right]+\underline{\lambda}_G(G_{H,w}-w_\eta)\\
&+ \lambda_{ICC,H}\{\pi_{H,w}\left[p_H R-(1+r)-(1-p_H)(1-\beta)G_{H,w}\right]\}\\
&- \lambda_{ICC,H}\{\left[p_H\left(R-\frac{1+r}{p_L}\right)-G_{L,w}\left[1-p_H-\frac{p_H}{p_L}(1-p_L)\beta\right]\right]\}\\
&+ \lambda_{ICC,L}\{\left[p_L R-(1+r)-(1-p_L)(1-\beta)G_{L,w}\right]\}\\
&- \lambda_{ICC,L}\{\pi_{H,w}\left[p_L(R-\frac{1+r}{p_H})-G_{H,w}\left[(1-p_L)-\frac{p_L}{p_H}\beta(1-p_H)\right]\right]\}
\end{aligned} \tag{A.11}$$

where we use

$$u_H=\pi_{H,w}\left[p_H R-(1+r)-(1-\beta)(1-p_H)G_{H,w}\right]+w \tag{A.12}$$

The FOCs are

$$\begin{aligned}
\frac{\partial\mathcal{L}}{\partial\pi_{H,w}} &= (1+\lambda_{ICC,H})(p_H R-(1+r)-(1-p_H)(1-\beta)G_{H,w})-\overline{\lambda}_\pi+\underline{\lambda}_\pi\\
&- \lambda_{ICC,L}\left[p_L(R-\frac{1+r}{p_H})-G_{H,w}\left[(1-p_L)-\frac{p_L}{p_H}\beta(1-p_H)\right]\right]=0
\end{aligned} \tag{A.13}$$

$$\begin{aligned}
\frac{\partial\mathcal{L}}{\partial G_{H,w}} &= -\pi_{H,w}(1+\lambda_{ICC,H})(1-p_H)(1-\beta)+\underline{\lambda}_G-\overline{\lambda}_G\\
&+ \lambda_{ICC,L}\pi_{H,w}\left[1-p_L-\frac{p_L}{p_H}(1-p_H)\beta\right]=0
\end{aligned} \tag{A.14}$$

Case 1: Wealth constraints are not binding, i.e. $G_{H,w}\in(w_\eta,w)$. In this case, $\underline{\lambda}_G=\overline{\lambda}_G=0$. Imposing this restriction, condition (A.14) can be rewritten as

$$\pi_{H,w}(1+\lambda_{ICC,H})(1-p_H)(1-\beta)=\lambda_{ICC,L}\pi_{H,w}\left[1-p_L-\frac{p_L}{p_H}(1-p_H)\beta\right] \tag{A.15}$$

We observe that, given assumption 1, for any level of wealth $G_{H,w} \leq (1+r)/\beta$,

$$p_H R - (1+r) - (1-p_H)(1-\beta)G_{H,w} > 0 \tag{A.16}$$

such that, in general, entrepreneurs are strictly better off the higher the probability of having access to credit is. Accordingly, $\pi_{H,w} = 1$ should hold if a borrower is not wealth-constrained. Based on this intuition, we solve the maximization problem assuming that $\pi_{H,w} = 1$ and then verify that this conjecture is confirmed.[30] Given $\pi_{H,w} = 1$, equation (A.15) implies $\lambda_{ICC,L} > 0$. Therefore, condition (A.6) holds as a strict equality. Accordingly, imposing $\pi_{H,w} = 1$ and solving that condition for $G_{H,w}$ yields

$$G_{H,w} = \frac{(1+r)(p_H - p_L) + p_H(1-p_L)(1-\beta)G_{L,w}}{(1-p_L)p_H - p_L(1-p_H)\beta} \tag{A.17}$$

Note that $G_{H,w} \geq G_{L,w}$ for $G_{L,w} \leq \frac{1+r}{\beta}$ holds, i.e., $G_{H,w} \geq G_{L,w}$ for $w \leq \frac{1+r}{\beta} + \eta$, as shown in figure 1.

We now need to verify that the ICC_H holds. In general, the following preliminary result applies

Lemma 2. *When the ICC_L is binding, the ICC_H is satisfied if and only if the following inequality holds:*

$$\frac{\pi_{H,w}}{\pi_{L,w}} \geq \frac{R - R_{L,w} + G_{L,w}}{R - R_{H,w} + G_{H,w}} \tag{A.18}$$

Proof. If the ICC_L is binding, then

$$\pi_{L,w}\left[p_L(R - R_{L,w}) - (1-p_L)G_{L,w}\right] = \pi_{H,w}\left[p_L(R - R_{H,w}) - (1-p_L)G_{H,w}\right] \tag{A.19}$$

Adding and subtracting $\pi_{H,w}\left[p_H(R - R_{H,w}) - (1-p_H)G_{H,w}\right]$, we obtain

$$\begin{aligned} &\pi_{H,w}(p_H - p_L)(R - R_{H,w} + G_{H,w}) + \pi_{L,w}\left[p_L(R - R_{L,w}) - (1-p_L)G_{L,w}\right] = \\ &\pi_{H,w}\left[p_H(R - R_{H,w}) - (1-p_H)G_{H,w}\right] \end{aligned} \tag{A.20}$$

Moreover, by adding and subtracting $\pi_{L,w}\left[p_H(R - R_{L,w}) - (1-p_H)G_{L,w}\right]$ from the expression for the payoff of an entrepreneur of type-L, we obtain

$$\begin{aligned} &\pi_{L,w}\left[p_L(R - R_{L,w}) - (1-p_L)G_{L,w}\right] = \\ &\pi_{L,w}\left[p_H(R - R_{L,w} - (1-p_H)G_{L,w}\right] - \pi_{L,w}(R - R_{L,w} + G_{L,w})(p_H - p_L) \end{aligned} \tag{A.21}$$

[30] We follow Besanko and Thakor, 1987.

Using (A.21) to substitute for $\pi_{L,w}\left[p_L(R-R_{L,w})-(1-p_L)G_{L,w}\right]$ in (A.20), we find that

$$\pi_{H,w}\left[p_H(R-R_{H,w})-(1-p_H)G_{H,w}\right]-\pi_{L,w}\left[p_H(R-R_{L,w})-(1-p_H)G_{L,w}\right]= \tag{A.22}$$
$$(p_H-p_L)\left[\pi_{H,w}(R-R_{H,w})+G_{H,w})-\pi_{L,w}(R-R_{L,w}+G_{L,w})\right]$$

Where the RHS is positive if and only if

$$\frac{\pi_{H,w}}{\pi_{L,w}}\geq\frac{R-R_{L,w}+G_{L,w}}{R-R_{H,w}+G_{H,w}} \tag{A.23}$$

□

In the case we are analyzing, $\pi_{H,w}=\pi_{L,w}=1$, and condition (A.23) reduces to

$$R-R_{L,w}+G_{L,w}\leq R-R_{H,w}+G_{H,w} \tag{A.24}$$

For $G_{L,w}<1+r/\beta+\eta$, $R_{H,w}<R_{L,w}$ holds (see also figure 3), meaning that, given $G_{H,w}>G_{L,w}$, the above inequality is always satisfied.

The above analysis relies on the assumption that the optimal solution satisfies PC_H. Substituting for the equilibrium contract, the PC_H reduces to

$$p_HR-(1+r)-(1-\beta)(1-p_H)G_{H,w}\geq G_{H,w}\Rightarrow G_{H,w}\leq\frac{p_HR-(1+r)}{(1-\beta)(1-p_H)} \tag{A.25}$$

where we note that the LHS is strictly decreasing in $G_{H,w}$. In the case we are analyzing, $G_{H,w}<(1+r)/\beta$. Hence, the PC_H is always satisfied as long as

$$\frac{p_HR-(1+r)}{(1-\beta)(1-p_H)}\geq\frac{1+r}{\beta} \tag{A.26}$$

which is the equivalent to the parameter restriction needed for assumption 1 to hold as explained below (see also condition A.32). Finally, given $G_{H,w}<(1+r)/\beta$, $G_{L,w}<(1+r)/\beta$ follows, meaning that this restriction is also sufficient for the PC of type-L agents to be satisfied.

Finally, note that given assumption 1 (see also condition A.32 below), $G_{H,w}<(1+r)/\beta$ and $p_HR-(1+r)-(1-\beta)(1-p_H)G_{H,w}>0$ hold for every value of $w\in[\underline{w},\overline{w}]$, and thus, the payoff of entrepreneurs evaluated at equilibrium levels of guarantees and the cost of credit is strictly increasing in the probability of having access to credit, which implies that $\pi_{H,w}=1$ is indeed optimal.

Case 2: $G_{H,w} \in (w_\eta, w]$ **is binding.** This case applies when

$$\frac{(1+r)(p_H - p_L) + p_H(1-p_L)(1-\beta)G_{L,w}}{(1-p_L)p_H - p_L(1-p_H)\beta} > w \tag{A.27}$$

and thus, safe entrepreneurs cannot afford the level of guarantees needed to enter contracts designed for their type and characterised by a probability of having access to credit $\pi_{H,w} = 1$. It follows from condition (A.14) that ICC_L must be binding. Accordingly, we find that

$$\pi_{H,w} = \frac{p_L R - (1+r) - (1-p_L)(1-\beta)w_\eta}{p_L R - \frac{p_L}{p_H}(1+r) - (1-p_L)w(1 - \frac{1-p_H}{1-p_L}\frac{p_L}{p_H}\beta)} \tag{A.28}$$

We need now to check that the above solution satisfies ICC_H. Substituting for the equilibrium values of $\pi_{H,w}$ and $\pi_{L,w}$, and imposing $G_{L,w} = w_\eta$ and $G_{H,w} = w$, condition (A.24) from lemma 2 can be rewritten as

$$\frac{R - R_{L,w} + w_\eta - \frac{w_\eta}{p_L}}{R - R_{H,w} + w - \frac{w}{p_L}} \geq \frac{R - R_{L,w} + w_\eta}{R - R_{H,w} + w} \tag{A.29}$$

We distinguish two cases: (1) $w \leq \eta$, meaning that $w_\eta = 0$; and (2) $w > \eta$, meaning that $w_\eta = w - \eta > 0$. In the first case, which applies for entrepreneurs sufficiently poor that their wealth, w, is less than the exemption level, η, condition (A.29) reduces to

$$\frac{R - R_{L,w}}{R - R_{H,w} + w - \frac{w}{p_L}} \geq \frac{R - R_{L,w}}{R - R_{H,w} + w} \tag{A.30}$$

and thus, ICC_H is always satisfied. In contrast, in case (2),(A.29) reduces to

$$w(R_{L,w} - R_{H,w}) \leq \eta(R - R_{H,w}) \tag{A.31}$$

However, note that, if ICC_H it is violated, then type-H would surely prefer pooling (which is better than the separating contract offered to type-L from type-H's perspective), with $w - \eta$ of guarantees (which is either the best pooling or the worst).

Credit Market participation by entrepreneurs. Given that in any SE, lenders' expected return equals $1 + r$, assumption 1 implies that all entrepreneurs are strictly willing to borrow in equilibrium, and thus, they all apply for credit. The explicit parameter restriction we need for assumption 1 to hold is the following:

$$p_\theta R - (1+r)\left[p_\theta + \frac{1-p_\theta}{\beta}\right] > 0, \qquad \theta = L, H \tag{A.32}$$

□

A.2 Proof of proposition 2

We provide a full characterization of SE under the assumption that entrepreneurs decide to disclose their wealth when borrowing. Later (see section A.4), we prove that this is indeed the case.

Given a candidate PE, the payoff of a borrower of type-$\theta = H, L$ and wealth w as a function of the equilibrium contract $\mathcal{C}_w^P = \{R_w^B, G_w, \pi_w)$ is

$$u_\theta^{PE} = \pi_w \{ R p_\theta - (1+r)\frac{p_\theta}{p_m} + G_w \left[(1-p_m)\frac{p_\theta}{p_m}\beta - (1-p_\theta) \right] \} \tag{A.33}$$

It can be seen immediately that the payoff is increasing in π_w for both types. Hence, given a candidate PE such that $\pi_w < 1$, profitable deviations exist, which destroy the equilibrium. Hence, $\pi_w = 1$ must hold. Moreover, if

$$\beta\frac{(1-p_m)}{p_m} < \frac{1-p_H}{p_H} \tag{A.34}$$

both types of entrepreneurs prefer less guarantees, and thus, $G_w = w - \eta$ must hold. Vice versa, if the reverse inequality holds, then safe entrepreneurs prefer more guarantees, and hence, any pooling contract must be characterised by $G_w = \min(w, \frac{1+r}{\beta})$.

Finally, given that in any PE, lenders expected return equal to $1 + r$, as it applied to SE, assumption 1 implies that all entrepreneurs are strictly willing to borrow in equilibrium, and thus, they all apply for credit. The explicit parameter restriction we need for assumption 1 to hold is given by (A.32) as long as (A.34) holds. Otherwise, if the reverse of (A.34) holds, the explicit parameter restrictions needed for assumption 1 to hold are given by (A.32) for $\theta = L$ and by

$$p_H R - (1+r)\frac{p_H}{p_L} > 0 \tag{A.35}$$

for $\theta = H$. □

A.3 Proof of proposition 3

As we did for SE, we provide a full characterization of PE under the assumption that entrepreneurs decide to disclose their wealth when borrowing. Later (see section A.4), we prove that this is indeed the case. We analyse first the case of rich entrepreneurs and then that of poor entrepreneurs.

a. Safe and rich. Under an SE, the payoff of a safe and rich entrepreneur is

$$p_H R - (1+r) - (1-\beta)(1-p_H)G_{H,w} \tag{A.36}$$

If such a borrower could apply for contract $\mathcal{C}^P$, her payoff would be

$$p_H R - (1+r)\frac{p_H}{p_m} - G_w(1-p_H) + \beta(1-p_m)\frac{p_H}{p_m}G_w \tag{A.37}$$

Hence, a strictly profitable deviation for lenders would then exist if and only if

$$p_H R - (1+r) - (1-\beta)(1-p_H)G_{H,w} < p_H R - (1+r)\frac{p_H}{p_m} + G_w(1-p_H)[\beta\frac{1-p_m}{1-p_H}\frac{p_H}{p_m} - 1] \tag{A.38}$$

which rearranging reduces to

$$(1+r)\frac{p_H - p_m}{p_m} < (1-\beta)(1-p_H)G_{H,w} - G_w p_H\left[\frac{1-p_H}{p_H} - \beta\frac{1-p_m}{p_m}\right] \tag{A.39}$$

Given

$$\beta\frac{1-p_m}{p_m} < \frac{1-p_H}{p_H} \tag{A.40}$$

$G_w = \min(w-\eta, (1+r)/\beta)$, and thus, the first-order derivative of the RHS of (A.39) with respect to w equals sero for $w \le \eta$, and[31]

$$\frac{(1-p_H)(1-\beta)^2}{1 - \frac{1-p_H}{1-p_L}\frac{p_L}{p_H}\beta} - (1-p_H)(1 - \frac{1-p_m}{p_m}\frac{p_H}{1-P_H}\beta) \tag{A.42}$$

for $w \ge \eta$. It is easy to show that the above derivative is strictly negative. Accordingly, let w_1 be the critical level of entrepreneurial wealth such that the entrepreneur is indifferent between the SE contract and $\mathcal{C}^P$, that is

$$w_1 : (1+r)\frac{p_H - p_m}{p_m} = (1-\beta)(1-p_H)G_{H,w} + G_w p_H\left[\frac{1-p_H}{p_H} - \beta\frac{1-p_m}{p_m}\right] \tag{A.43}$$

Then, we have the following:

Case i. If $\overline{w} < w_1$, then all rich and safe entrepreneurs separate from risky entrepreneurs, i.e., the SE prevails.

Case ii.] If $\widehat{w} > w_1$, then all rich and safe borrowers pool, i.e., the PE prevails.

Case iii. Finally, if $w_1 \in [\widehat{w}, \overline{w}]$, then all borrowers with wealth $w < w_1$ separate, while all borrowers with $w > w_1$ pool.

[31] We use $G_w = G_{L,w} = \max(w-\eta, 0)$ holds, and

$$G_{H,w} = \frac{(1+r)(p_H - p_L) + p_H(1-p_L)(1-\beta)G_{L,w}}{(1-p_L)p_H - p_L(1-p_H)\beta} \tag{A.41}$$

Conversely, if

$$\beta\frac{(1-p_m)}{p_m} > \frac{1-p_H}{p_H} \tag{A.44}$$

holds, $G_w = w$, and thus, $G_{H,w} < G_w$. However, then all safe and rich borrowers always strictly prefer to separate from risky entrepreneurs, meaning that the equilibrium will be separating.

b. Safe and poor. The equilibrium payoff for a safe and poor entrepreneur is

$$\pi_{H,w}[p_H R - (1+r) - (1-p_H)(1-\beta)G_{H,w}] \tag{A.45}$$

If the entrepreneur could apply for $\mathcal{C}^P$, the payoff would be

$$p_H R - (1+r)\frac{p_H}{p_m} - (1-p_H)G_w\left[1 - \frac{1-p_m}{p_m}\frac{p_H}{1-p_H}\beta\right] \tag{A.46}$$

Therefore, there exists a profitable deviation for lenders if

$$\pi_{H,w}[p_H R - (1+r) - (1-p_H)(1-\beta)G_{H,w}] < p_H R - (1+r)\frac{p_H}{p_m} - (1-p_H)G_w\left[1 - \frac{1-p_m}{p_m}\frac{p_H}{1-p_H}\beta\right] \tag{A.47}$$

Consider first the case in which

$$\beta\frac{1-p_m}{p_m} < \frac{1-p_H}{p_H} \tag{A.48}$$

such that $G_w = w - \eta$. Rearranging terms, the above condition can be written as

$$\pi_{H,w}[p_H R - (1+r) - (1-p_H)(1-\beta)G_{H,w}] < p_H R - (1+r)\frac{p_H}{p_m} - G_w p_H\left[\frac{1-p_H}{p_H} - \beta\frac{1-p_m}{p_m}\right] \tag{A.49}$$

Define, w_2 the value of wealth such that

$$\pi_{H,w_2}[p_H R - (1+r) - (1-p_H)(1-\beta)G_{H,w_2}] = p_H R - (1+r)\frac{p_H}{p_m} - G_{w_2} p_H\left[\frac{1-p_H}{p_H} - \beta\frac{1-p_m}{p_m}\right] \tag{A.50}$$

It is immediate to verify that the RHS of condition (A.49) is decreasing in w while the RHS is increasing in w.[32] Accordingly, we have the following:

i. If $w_2 > \widehat{w}$, then all poor and safe entrepreneurs pool with risky entrepreneurs.

ii. If $w_2 < \underline{w}$, then all poor and safe separate.

iii If $w_2 \in [\underline{w}, \widehat{w}]$, then poor and safe entrepreneurs with $w \in [\underline{w}, w_2]$ pool while the rest separate.

[32] Poor and safe agents are wealth-constrained in an SE, meaning that increasing w increases their SE payoff. The first-order derivative of the LHS equals $\lambda_{\underline{G}} > 0$

Consider now the case in which

$$\beta \frac{1-p_m}{p_m} > \frac{1-p_H}{p_H} \tag{A.51}$$

such that $G_w = w = G_{H,w}$ holds.

First, we note that the RHS of condition (A.49) is linear in w with a strictly positive first-order derivative

$$-p_H \left[\frac{1-p_H}{p_H} - \beta \frac{1-p_m}{p_m} \right]$$

The LHS of (A.49) is the objective function of maximization problem A.4. Accordingly, its derivative with respect to w in the case of poor entrepreneurs, who are wealth-constrained, is equal to the Lagrangian multiplier associated with the constraint $G_{H,w} \leq w$, $\lambda_{\overline{G}}$, which has the following expression

$$\lambda_{\overline{G}} = -\pi_{H,w}(1-p_H)(1-\beta) + \lambda_{ICC,L} \left[1 - p_L - \frac{p_L}{p_H}(1-p_H)\beta \right] \tag{A.52}$$

It is immediate to verify that its value is indeed positive, as it should be. First, we note that $(1-p_H)(1-\beta)$ is strictly less than $1 - p_L - p_L(1-p_H)\beta/p_H$. Second, the equilibrium value of $\lambda_{ICC,L}$ is

$$\lambda_{ICC,L} = \frac{p_H(R-R_H) - (1-p_L)G_{H,w}}{p_L(R-R_H) - (1-p_L)G_{H,w}} \tag{A.53}$$

Comparison with the corresponding expression for the equilibrium value of $\pi_{H,w}$ yields $\lambda_{ICC,L} > \pi_{H,w}$ as long as the ICC of type-H is satisfied.

Furthermore, for $w \to 0$, condition (A.49) reduces to

$$\frac{p_L R - (1+r)}{p_L R - (1+r)\frac{p_L}{p_H}}(p_H R - (1+r)) < p_H R - (1+r)\frac{p_H}{p_m} \Rightarrow -(p_H - 1 + r)(1 - \frac{p_L}{p_m}) < 0 \tag{A.54}$$

which is always true, and thus, for sufficiently low levels of wealth, poor and safe entrepreneurs deviate to pooling. The opposite is true for $w \to \widehat{w}$, meaning that no profitable deviation exists in that case.

Finally, the second-order derivative of $\lambda_{\overline{G}}$ yields

$$\frac{\partial \lambda_{\overline{G}}}{\partial w} = -\frac{\partial \pi_{H,w}}{\partial w}(1-p_H)(1-\beta) + \frac{\partial \lambda_{ICC,L}}{\partial w} \left[1 - p_L - \frac{p_L}{p_H}(1-p_H)\beta \right] \tag{A.55}$$

which can be proved is strictly negative. Accordingly, there exists w_2 as defined by equation (A.50), such that pooling takes place for $w < w_2$ while separation occurs for $w > w_2$. $\square$

A.4 Incentives to disclose wealth

We characterised SE and PE under the assumption that entrepreneurs are disclosing their wealth when borrowing. The following result holds.

Lemma 3 (Wealth disclosure)**.** *In any equilibrium, entrepreneurs always disclose their wealth when borrowing.*

Proof.

Let us first analyse the incentives that safe borrowers have to disclose their wealth in an SE. In any SE, ICC_L holds as a strict equality. That is,

$$[p_L(R-(1+r)-(1-\beta)(1-p_L)G_{L,w}] = \pi_H[p_L(R-R^H_{H,w})-(1-p_L)G_{H,w}] \tag{A.56}$$

We note that the LHS of the above constraint is decreasing in $G_{L,w}$. Let $\mathcal{E}'$ be the set of entrepreneurs who are not disclosing their wealth in a candidate equilibrium and $\overline{w}(\mathcal{E})$ the highest value of individual wealth of entrepreneurs in that set. Since $G_{L,w}$ is increasing in w, the contract $\mathcal{C}_H = (\pi_H, R^B_H, G_H)$ offered to any entrepreneur of type-H who is not disclosing his wealth must satisfy

$$[p_L R-(1-p_L)(1-\beta)\min(\max(\overline{w}(\mathcal{E}),0)-\eta,(1+r)/\beta] = \pi_H[p_L(R-R^B_H)-(1-p_L)G_H] \tag{A.57}$$

Crucially, for a risky entrepreneur with wealth $w_1 < \eta+(1+r)/\beta$, where w_1 is defined by equation (31), the above constraint is satisfied as a strict inequality. Hence, entrepreneurs of type-H with the same level of wealth equal to w_1 have an incentive to disclose their wealth because in that case they can be offered a contract conditional on the wealth level, which needs to satisfy only ICC_L for risky entrepreneurs endowed with that level of wealth, that is

$$\pi_L[p_L(R-R^L_L)-(1-p_L)(\max(w_1-\eta),0) = \pi_{H,w_1}[p_L(R-R^B_{H,w_1})-(1-p_L)G_{H,w_1}] \tag{A.58}$$

which is less strict than the above and therefore allows either for a greater probability of having access to credit (for poor and safe entrepreneurs), or a lower level of guarantees (for rich and safe entrepreneurs). This directly implies that, given an SE in which safe entrepreneurs with wealth w such that $w-\eta<(1+r)/\beta$ are not disclosing their wealth, lenders have an incentive to propose contracts that require safe borrowers to disclose their wealth, as by doing so they can make additional profits and surely attract borrowers.[33]

Let us now turn to the incentives of risky entrepreneurs to disclose their wealth when borrowing.

Let $\omega(w|e \in \mathcal{E}')$, where we recall that $\mathcal{E}$ is the entrepreneurs' set, be the equilibrium expected value of wealth for an entrepreneur who is not disclosing her wealth, with $\omega(w|e \in \mathcal{E}') < \overline{w}(\mathcal{E}'))$. In equilibrium, lenders break even in expected terms, given the information available. Hence, for each borrower e with $e \in \mathcal{E}'$, the equilibrium contract satisfies

$$p_H R^B_{L,\omega(w|e\in\mathcal{E}')} + (1-p_H)\beta G_L = 1 + r \tag{A.59}$$

where, $G_L = \min(\max(\omega(w|e \in \mathcal{E}') - \eta, 0), \frac{R^B_{L,\omega(w|e\in\mathcal{E}')}}{\beta})$. It is then immediate to verify that – unless $\omega(w|e \in \mathcal{E}') = (1+r)/\beta$ – if disclosing her wealth, the richest entrepreneur who is not disclosing it would be better off by doing so, as she will increase the level of expected guarantees she is offering the lenders, thereby reducing the cost of credit, which destroys the candidate equilibrium.

Equivalent arguments can be made for the case of a pooling equilibrium. □

B Simultaneous structural relationship between of cost of credit and guarantees

According to the model, the equilibrium levels of the entrepreneurs' guarantees conditional on entrepreneurs' type, G_L, and G_H, and the corresponding values of the cost of credit , R^B_H and R^B_L– none of which is affected by the probability of having access to credit – are simultaneously determined. Therefore, consistent with the model, we also estimate a system of two equations for the cost of credit as a function of the guarantees and the amount of guarantees as a function of the cost of credit. Following the model, $\hat{w}$ is the level of wealth above which a safe borrower is always financed. Let G^* be the unobserved level of guarantees such that when $G^* \geq \hat{w}$, a safe borrower is always financed. We do not observe G^*, but we do observe the variable

[33] Note that the above argument does not hold for safe entrepreneurs endowed with levels of wealth such that $w - \eta \geq (1+r)/\beta$. However, whether these borrowers disclose their wealth is irrelevant in terms of the equilibrium outcome. Moreover, this case is ruled out by assumption 1.

$$G = \begin{cases} 1 & \text{if } G^* \geq \hat{w} \\ 0 & \text{otherwise} \end{cases} \tag{B.1}$$

The dummy G_i, which takes value 1 if firm i posts collateral and it is always financed, zero otherwise – i.e., if firm i does not post collateral or it posts collateral and is financed only sometimes. We use this variable as a discrete measure of, or proxy for, the level of guarantees. Accordingly, the simultaneous equation model is as follows:

$$R_i^B = \gamma_1 G_i + \psi_{\mathbf{1}} \mathbf{X_{i,1}} + \varepsilon_{R,i} \tag{B.2}$$

$$G_i = \gamma_2 R_i^B + \psi_{\mathbf{2}} \mathbf{X_{i,2}} + \varepsilon_{G,i} \tag{B.3}$$

where R_i^B is a continuos endogenous variable (interest rate), $\mathbf{X_{i,1}}$ and $\mathbf{X_{i,2}}$ are vectors of exogenous variables, $\psi_{\mathbf{1}}$ and $\psi_{\mathbf{2}}$ are the vectors of coefficients associated with the exogenous variables, γ_1 and γ_2 are the coefficients of the endogenous variables, and $\varepsilon_{R,i}$ and $\varepsilon_{G,i}$ are the error terms.[34]

We expect the following results:

1. a negative effect of guarantees on the loan rate;

2. a larger negative effect of guarantees on the loan rate for firms located in high-exemption census divisions.

In the second column of table 7, we report the estimation results of the simultaneous equation model for the full sample. We find a negative relationship between R^B and G. Other things being equal, posting guarantees is associated with an average reduction in the cost of credit of 47 basis points. Consistently, a higher interest rate is associated with a lower probability of posting guarantees, as measured by our proxy. Assuming that the decision to post guarantees is endogenous, we do not include the interaction term between exemption and guarantees in the estimation, which would be endogenous by construction. To identify the signaling value of guarantees, we estimate the model while splitting the sample into two subsamples, one including firms located in groups of states with unlimited homestead and personal property exemption (the high exemption dummy equals one) and

[34] The estimation procedure for the two-stage probit least squares approach is described in Maddala and Lee, 1976, Maddala, 1983, and Keshk, 2003.

the other including firms located in all other groups of states. The results are reported in the last two columns of table 7. The reduction in the cost of credit associated with posting guarantees is nearly three times larger (93 vs 34 basis points) when moving to the census divisions with above-average exemption levels. Again, we cannot reject the model's predictions, which offers further support for the idea that collateral plays a role as sorting device.

C Selection (Not meant for publication)

The key issue is that rationing, the decision to post collateral, and the cost of credit are observable only for creditworthy firms applying for credit. To account for the possibility of sample selection, we model access to credit as a selection process based on the decision tree portrayed in figure 7. In the first stage, an entrepreneur decides whether to apply for a loan. If applying – in stage 2 – the entrepreneur can be evaluated as creditworthy or not by the bank. Finally, in stage 3 – of the creditworthy entrepreneurs, some will be always financed and some will be rationed with some positive probability.

C.1 Selection into the creditworthy group

Firms are considered creditworthy by the bank provided that they apply for a loan. Hence, we estimate a two-equation model in which the first equation represents the firm's decision to apply, while the second equation estimates the probability that the firm is creditworthy. From the linear prediction of this second equation, we obtain the inverse Mills ratio, $\lambda_{i,CW}(\cdot)$, that we employ in the last stage to estimate the equation for the cost of credit.

We employ maximum likelihood to estimate the following bivariate probit model with selection:

$$A_i = \theta \mathbf{F}_i + \epsilon_i \tag{C.1}$$

$$CW_i = \delta \mathbf{W}_i + \xi_i \tag{C.2}$$

where A_i is a dichotomous variable equal to 1 if a firm applied for a loan; $\mathbf{F}_i$ is a set of determinants of a firm's decision to apply; θ is a vector of parameters; ϵ_i and ξ_i are the correlated error terms; $CW_i = 1$ for creditworthy entrepreneurs; $\mathbf{W}_i$ is a set of publicly known variables that determine the firm's credit worthiness; and δ is a vector of parameters.

Equation C.1 is the selection equation, while equation C.2 estimates firms' probability of being creditworthy. The ML estimation results are not reported and can be provided on request. We reject the null hypotheses of the independence of the two equations.

C.2 Cost of credit with selection

For creditworthy firms, the cost of credit is determined according to the following empirical specification equivalent to model (49), which we estimated not accounting for selection,

$$R_i^B = \beta_1 \mathbf{X}_i + \beta_2 \eta_i + \beta_3 C_i + \beta_4 C_i \eta_i + v_i \tag{C.3}$$

where v_i is the error term.

We assume that $(v_i, \xi_i) \sim N(0, 0, \sigma_v, \sigma_\xi, \rho)$, where ρ is the correlation coefficient. Taking expectations, we obtain the regression model for R^B:

$$E(R_i^B \mid CW_i = 1) = E(R_i^B \mid \xi_i > -\delta \mathbf{W}_i) = \beta_1 \mathbf{X}_i + \beta_2 \eta_i + \beta_3 C_i + \beta_4 C_i \eta_i + \rho\sigma \frac{\phi(\delta \mathbf{W}_i)}{\Phi(\delta \mathbf{W}_i)} \tag{C.4}$$

Note that, as we are modeling the cost of credit for those entrepreneurs who are selected to be creditworthy, $\lambda_{i,CW}(-\delta \mathbf{W}_i) = \frac{\phi(\delta \mathbf{W}_i)}{\Phi(\delta \mathbf{W}_i)}$ represents the inverse Mills ratio.

According to the above, the econometric specification for the cost of credit – that accounts for selection – is given by

$$R_i^B = E(R_i^B \mid CW_i = 1) + e_i \tag{C.5}$$

where $e_i \sim iid(0, \sigma_e)$.

Estimates of the vector $\lambda_{i,CW}(\cdot)$ are obtained from the bivariate probit with selection of equations (C.1) and (C.2) for CW_i.

C.3 Access to credit with selection

The financing process depicted in figure 7 shows that a borrower can be always financed or not conditional on the fact that she is creditworthy. Once the bank selects the creditworthy borrowers, depending on their type, it offers contracts that may involve a probability of having access to credit that is less than one. This selection is taken into account when estimating the following bivariate probit with selection:

$$CW_i = \delta \mathbf{W}_i + \xi_i \tag{C.6}$$

$$\pi_i = \boldsymbol{\alpha_1} \mathbf{Y_i} + \alpha_2 \eta_i + \alpha_3 C_i + \alpha_4 C_i \times \eta_i + \alpha_5 \frac{R^B_{L,i}}{R'^B_{H,i}} + u_i \tag{C.7}$$

where the first equation has been already defined, and the second equation is equivalent to model (48), which we estimated not accounting for selection.

C.3.1 Results

In table 8, we report the results of the estimation of the cost of credit including among the regressors the inverse Mills ratio from the estimation of the probability of being creditworthy conditional on having submitted a loan application. Table 9 reports the marginal effects of the variables in the model with selection in equations (C.6) and (C.7). The signs of the relevant dummies, high exemption, posting collateral and their interaction, are as in the model without selection. The estimated parameters are very close to those estimated without accounting for selection. The positive effect of collateral in high-exemption areas increases substantially in the estimation with selection.
The estimation with sample selection confirms the findings on the sorting role of collateral.

C.3.2 Simultaneous model with sample selection

Sample selection is also considered in the estimation of the joint determination of the cost of credit and guarantees by augmenting the model by the inverse Mills ratio. These results are reported in table 10. The marginal effect of guarantees on the cost of credit is unchanged for the full sample and substantially the same both in the low-exemption (-0.17 vs -0.18) and high-exemption subsamples (-0.75 vs -0.73).

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Table 1: Loan rate and fraction of rationed firms by exemption, collateral and assets

		Any asset			Low asset			High asset		
		FS	LEX	HEX	FS	LEX	HEX	FS	LEX	HEX
C=1	Loan rate (%)	5.49	5.53	5.37	6.06	6.13	5.89	5.08	5.12	4.96
C=0	Loan rate (%)	6.19	6.06	6.57	6.95	6.8	7.42	5.04	5.02	5.12
C=1	Rationed firms (%)	4.5	4.7	3.8	8.1	8.6	6.7	1.9	2.0	1.5
C=0	Rationed firms (%)	3.0	1.9	6.5	3.7	2.3	7.7	1.9	1.2	4.4
Any firm	Loan rate (%)	5.81	5.78	5.90	6.55	6.50	6.70	5.06	5.08	5.02
Any firm	Rationed firms (%)	3.8	3.4	5.0	5.7	5.1	7.2	1.9	1.7	2.5

FS: Full sample; LEX: Low exemption; HEX: High exemption.

Low asset: assets below median value; High asset: assets above the median value.

Table 2: Probability to post collateral

Variable	coefficient
Dummy=1 if firm's credit score is in the top 25%	-0.9022***
Loan original maturity (n. of months)	0.0050***
Amount granted over total applied	-0.1786***
Banking market concentration: Dummy=1	
if Herfindahl index>1800	0.1216***
Dummy=1 if firm has limited liability	0.3031***
Dummy=1 if owner is female	-0.2112***
Years of firm-bank relationship	-0.0042***
Dummy=1 if firm is family owned	-0.0837***
N	1615
χ^2	105.6

Significance levels : $*$: 10% $**$: 5% $***$: 1%.

Table 3: Cost of credit - Switching regression

Variable	R_L^B	R_H^B	R'^B_H	R'^B_L
Inverse Mills ratio λ_i	-0.5447**	-0.2754*	-0.1933	-0.2585**
Dummy=1 if firm located in high-exemption area	0.2178**	-0.2023***	0.2139**	-0.1982***
Total assets - thousands of $	-0.000001	-0.000005**	-0.0000004**	-0.000005*
Total assets× High exemption dummy	-0.00001**	0.0000004	-0.00001**	0.0000004
Dummy=1 if firm's credit score is in the top 25%	-0.1574	-0.0667	-0.1349	-0.0680
Dummy=1 if the fixed interest rate	0.9891***	1.1680***	0.9863***	1.1657***
Dummy=1 if the loan was a new line of credit	-0.1388	-0.4242***	-0.1203	-0.4294***
Banking market concentration: Dummy=1				
if Herfindahl index>1800	0.3831***	0.1156**	0.3461***	0.1182**
Owner's managerial experience (n. of years)	-0.0297***	-0.0095***	-0.0300***	-0.0095***
Dummy=1 if owner is black	1.6548***	-0.7073***	1.6626***	-0.7103**
Dummy=1 if owner belongs to an ethnic				
minority other than black	1.3748***	0.0665	1.3506***	0.0696
Dummy=1 if owner is female	-0.2358*	-0.1359	-0.1876	-0.1355
Dummy=1 if firm is family owned	-0.0939	-0.2815***	-0.0748	-0.2809***
Number of credit applications	-0.0065	0.0434***	-0.0148	0.0438***
Years of firm-bank relationship	-0.0200***	0.0018	-0.0188***	-0.0018
Distance of firm from bank (miles)	0.0014**	-0.0001	0.0015**	-0.0001
Natural log of total sales	-0.3829***	-0.2198***	-0.3844***	-0.2225***
Debt over total asset	0.0237	0.0313***	0.0233	0.0317***
Intercept	12.1981***	8.5600***	11.6574***	9.0331***
N	697	881	697	881
R^2	0.20	0.19	0.20	0.19
F	9.66	12.43	9.61	12.46

Significance levels : $*$: 10% $**$: 5% $***$: 1%.

Table 4: Probability of having access to credit - marginal effects

Variable	**(1)**	**(2)**
Dummy=1 if firm located in high-exemption area	-0.0289***	-0.0176***
Dummy=1 if firm posted collateral	-0.0113***	-0.0114**
Dummy=1 if firm posts collateral and is located in high-exemption area	0.0128***	0.0218**
$\mathrm{R}_L^B / R_H^{\prime B}$	-1.0294***	-1.0242***
Loan original maturity (n. of months)	-0.0002***	-0.0002***
Amount granted over total applied	0.0445***	0.0448***
Years of firm-bank relationship	0.0005***	0.0004**
Dummy=1 if firm's credit score is top 25%	0.0108***	0.0117**
Dummy=1 if firm has delinquency records	-0.0051***	-0.0051 ***
Debts over equity	-0.0001**	-0.0001
Dummy=1 if firm has limited liability	-0.0034	0.0037
Total assets - thousands of $	0.000001***	0.000001***
N	1591	1591
Log-likelihood	-209.42	—
$\chi^2_{(12)}$	86.08	—

Significance levels : $*$: 10% $**$: 5% $***$: 1%. Column (1) reports probit estimation; column (2) probit estimation taking into account the imputation of data.

Table 5: Probability of having access to credit: Adjusted predictions

Variable			adjusted predictions
Dummy high-exemption areas			
		0	0.9803***
		1	0.9841***
Dummy post collateral			
		0	0.9920***
		1	0.9860***
High exemption and post collateral			
	0	0	0.9948***
	0	1	0.9847***
	1	0	0.9742***
	1	1	0.9895***

Significance levels : $*$: 10% $**$: 5% $***$: 1%.

Table 6: Cost of credit

Variable	(1)	(2)
Dummy=1 if firm located in high-exemption area	0.2612***	0.2354
Dummy=1 if firm posted collateral	-0.3353***	-0.3388**
Dummy=1 if firm posts collateral and is located in high-exemption area	-0.5248***	-0.4958**
Dummy=1 if firm's credit score is top 25%	-0.0936*	-0.0835
Dummy=1 if the fixed interest rate	1.0964***	1.0878***
Dummy=1 if loan was a new line of credit	-0.2311**	-0.2363
Banking market concentration: Dummy=1 if Herfindahl index> 1800	0.2544***	0.2532**
Owner's managerial experience (n. of years)	-0.0164***	-0.0163***
Dummy=1 if owner is black	0.7574***	0.7453
Dummy=1 if owner belongs to an ethnic minority other than black	0.8217***	0.8255***
Dummy=1 if owner is female	-0.0988	-0.0988
Dummy=1 if firm is family owned	-0.2275***	-0.2293*
Number of credit applications	0.0292	0.0295
Years of firm-bank relationship	-0.0091***	-0.0091
Distance of firm from bank (miles)	0.0011***	0.0011
Natural log of total sales	-0.3177***	-0.3199***
Debt over total assets	0.0232***	0.0229
Total assets - thousands of $	-0.000005**	0.000005
Intercept	10.6677***	10.7019***
N	1671	
R^2	0.19	-
F	23.23	21.25

Significance levels : $*$: 10% $**$: 5% $***$: 1%.

Column (1) reports the OLS estimation; column (2) reports the OLS estimation taking into account the imputation of data.

Table 7: Simultaneous model

	Whole sample	Low exemption	High exemption
	Dependent variable Loan rate (R^B)		
Guarantees	-0.3467***	-0.1766***	-0.7525***
Dummy=1 if firm's credit score is in the top 25%	-0.1329**	0.0148	-0.7058***
Dummy=1 if the fixed interest rate	1.0631***	1.1377***	0.8918***
Dummy=1 if loan was a new line of credit	-0.3332***	-0.2134	-0.7078***
Banking market concentration:			
Dummy=1 if Herfindahl index> 1800	0.2512***	0.1118*	0.6743***
Owner managerial experience (n. of years)	-0.0157***	-0.0201***	0.0018
Dummy=1 if owner is black	0.6584 ***	0.6765***	0.9328**
Dummy=1 if owner belongs to an			
ethnic minority other than black	0.6247***	0.2921**	1.3701***
Dummy=1 if owner is female	-0.1081	-0.1634*	0.2247
Dummy=1 if firm is family owned	-0.2239***	-0.2460***	-0.3276**
Number of credit applications	0.0306	0.0280**	-0.0330
Years of firm-bank relationship	-0.0102***	-0.0070**	-0.0201***
Distance of firm from bank (miles)	0.0006***	0.0009**	-0.0006
Natural log of total sales	-0.2725***	-0.2568***	-0.3182***
Debt over total assets	0.0276***	0.0256*	0.0242***
Total assets - thousands of $	-0.000004**	-0.000005*	-0.000003
Intercept	9.8520***	9.6905***	10.4263***
R^2	0.18	0.17	0.25
F	22.65	13.81	8.28
	Dependent variable Guarantees (G)		
Loan Rate	-0.2305***	-0.2420***	-0.1805***
Loan original maturity (n. of months)	-0.0043***	0.0044***	-0.0044***
Amount granted over total applied	-0.1737***	-0.1695***	-0.1699**
Years of firm bank relationship	-0.0072***	-0.0087***	-0.0023
Dummy=1 if firm's Credit score is top 25%	-0.1129***	-0.0533	-0.2983***
Banking market concentration:			
Dummy=1 if Herfindahl index> 1800	0.1486***	0.1520***	0.1221**
Dummy=1 if firm has limited liability	0.0926**	0.0805*	0.1740*
Dummy=1 if owner is female	-0.1539***	-0.2405***	0.0786
Dummy=1 if firm is family owned	-0.1141***	-0.0697	-0.3052***
Intercept	1.5363***	1.5461***	1.2901***
LR χ^2	127.25	115.53	37.73
N. obs	1578	1183	395

Significance levels : $*$: 10% $**$: 5% $***$: 1%

Two-stage probit least squares estimation (Maddala and Lee, 1976; Keshk, 2003)

Table 8: Cost of credit with selection

Variable	(1)	(2)
Dummy=1 if firm located in high-exemption area	0.2348***	0 .2101
Dummy=1 if firm posted collateral	-0.3484***	-0.3510**
Dummy=1 if firm posts collateral and is located in high-exemption area	-0.4982***	-0.4699*
Dummy=1 if firm's credit score is in the top 25%	0.1002*	0.1152
Dummy=1 if the fixed interest rate	1.0869***	01.0795***
Dummy=1 if loan was a new line of credit	-0.2268***	-0.2309
Banking market concentration: Dummy=1 if Herfindahl index> 1800	0.2531***	0.2531**
Owner's managerial experience (n. of years)	-0.0147***	-0.0146**
Dummy=1 if owner is black	0.7539***	0.7397
Dummy=1 if owner belongs to an ethnic minority other than black	0.8397***	0.8441***
Dummy=1 if owner is female	-0.1208*	-0.1201
Dummy=1 if firm is family owned	-0.3162***	-0.3204**
Number of credit applications	0.0266	0.0267
Years of firm-bank relationship	-0.0092***	-0.0092
Distance of firm from bank (miles)	0.0012***	0.0012
Natural log of total sales	-0.2823***	-0.2832***
Debt over total assets	0.0106	0.0100
Total assets - thousands of $	-0.000005**	0.000004
Inverse Mills ratio from Creditworth (eq. C.2)	1.4026***	1.4344***
Intercept	9.8845***	9.8930***
N	1664	
R^2	0.19	-
F	22.36	20.47

Significance levels : $*$: 10% $**$: 5% $***$: 1%

Column (1) reports the OLS estimation; column (2) reports the OLS estimation controlling for the imputation of data.

Table 9: Marginal effects for the probability of access to credit : Bivariate probit with selection (selection equation: probability of being creditworthy)

Variable	
Dummy=1 if firm located in high-exemption area	-0.0268
Dummy=1 if firm posted collateral	-0.0121***
Dummy=1 if firm posts collateral and is located in high-exemption area	0.0233***
$\mathrm{R}_L^B / R_H'^B$	-1.0617***
Loan original maturity (n. of months)	0.0002***
Amount granted over total applied	0.0460***
Years of firm-bank relationship	0.0005***
Dummy=1 if firm's credit score is in the top 25%	0.0100***
Dummy=1 if firm has delinquency records	-0.0049***
Debts over equity	-0.0001**
Dummy=1 if firm has limited liability	-0.0038**
Total assets - thousands of $	0.000001***
N	1721
Censored observations	130
Uncensored observations	1591
ρ	-0.688
LR test of indep. eqns. ($\rho = 0$)	$\chi^2 = 13.96$

Significance levels : $*$: 10% $**$: 5% $***$: 1%

Table 10: Simultaneous model with selection

	Whole sample	Low exemption	High exemption
		Dependent variable Loan rate (R^B)	
Guarantees	-0.3477***	-0.1892**	-0.7393***
Inverse Mills ratio	1.4906***	1.6548***	0.4348
R^2	0.18	0.17	0.25
F	21.79	14.98	7.91
		Dependent variable Guarantees (G)	
Loan Rate	-0.2338***	-0.2587***	-0.1558***
Inverse Mills's ratio	0.1822	0.5413***	-0.7643***
LR χ^2	125.47	93.48	41.50
N. obs	1571	1178	394

Significance levels : $*$: 10% $**$: 5% $***$: 1%

Two-stage probit least squares estimation (Maddala, Lee, 1976; Keshk, 2003)

List of controls: Dummy Fixed interest rate; Dummy new line of credit; Dummy Credit score top 25%; Number of credit applications; Total sales; Banking market concentration; Owner managing experience (n. of years); Dummy female owner; Dummy black owner; Dummy other minority owner; Years of firm bank relationship; Distance of firm from bank; Debt over total assets; Dummy family owned, Firm Asset. Inverse Mills ratio calculated by the estimation of probability of a firm being creditworthy given that it applied for a loan (see equations C.1 and C.2)

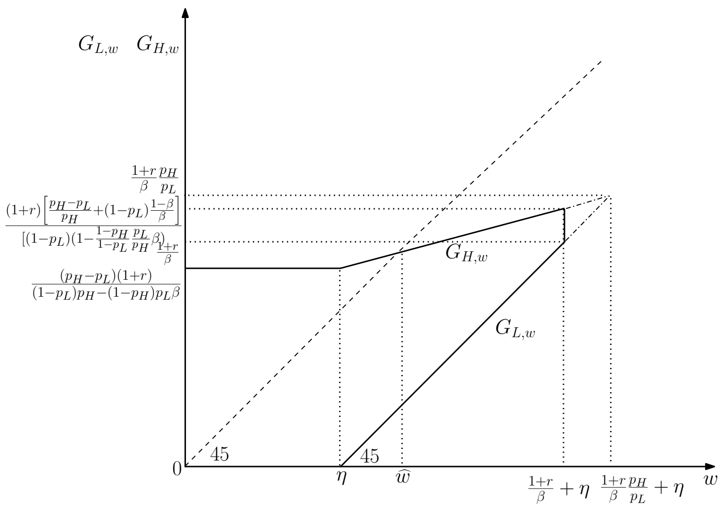

Figure 1: Separating equilibrium: Real guarantees by borrower's type. The picture is built under the assumption that $\widehat{w} \in (\eta, \frac{(1+r)}{\beta})$.

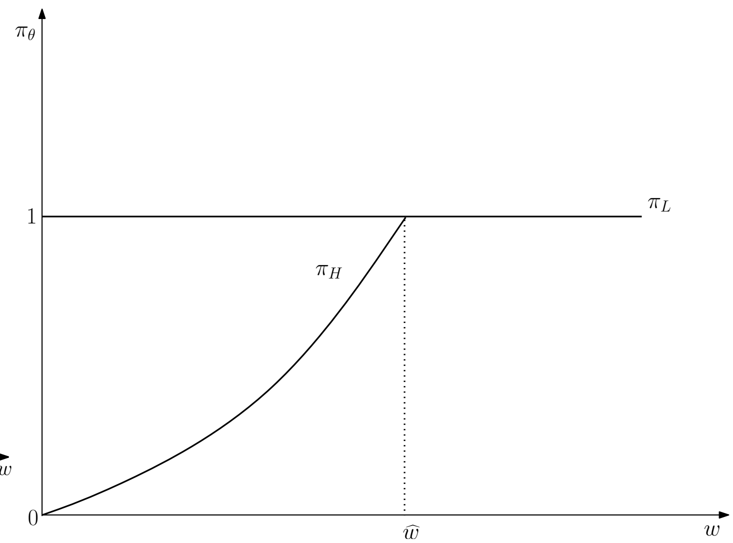

Figure 2: Separating equilibrium: probability of having access to credit by borrower's type.

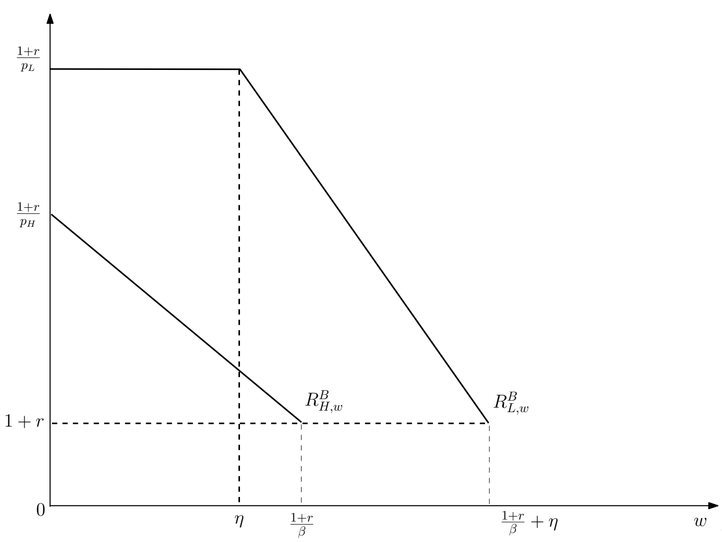

Figure 3: Separating equilibrium: Cost of credit by borrower's type. Note that this picture is built substituting the equilibrium level of guarantees into equation 13.

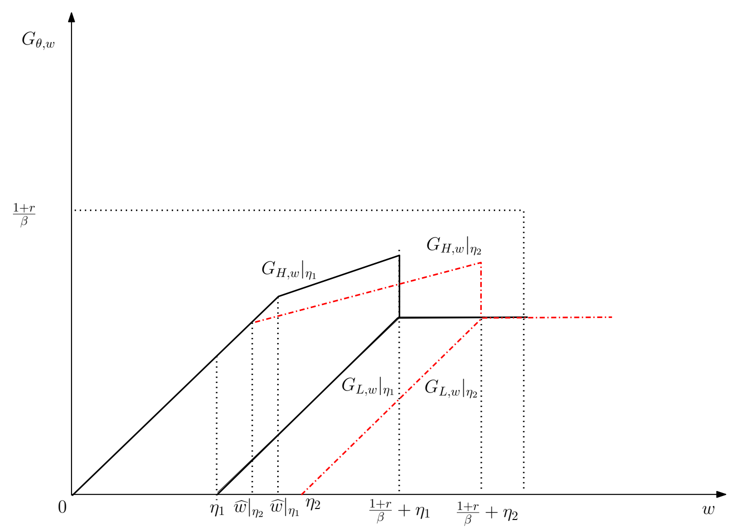

Figure 4: Separating equilibrium and probability of having access to credit: Exemption and levels of guarantees. The picture plots the level of guarantees under two different levels of exemption, η_1 (continuos line) and η_2 (dash dotted line), with $\eta_2 > \eta_1$.

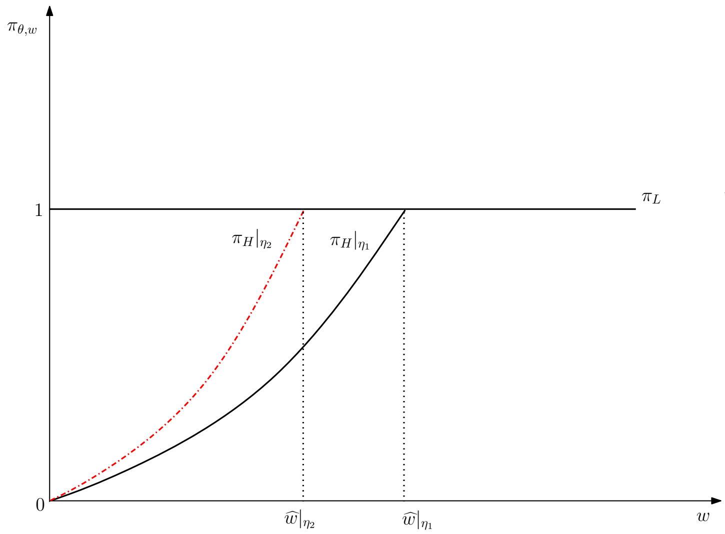

Figure 5: Separating equilibrium: Exemption and probability of having access to credit. The picture plots the probability of having access to credit under two different levels of exemption, η_1 (continuous line) and η_2 (dash dotted line), with $\eta_2 > \eta_1$.

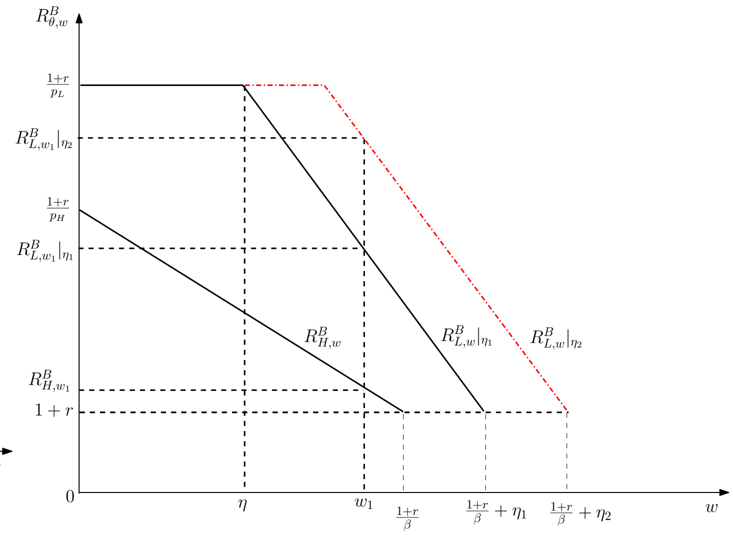

Figure 6: Separating equilibrium: Exemption and cost of credit. The picture plots the cost of credit under two different levels of exemption, η_1 (continuos line) and η_2 (dash dotted line), with $\eta_2 > \eta_1$.

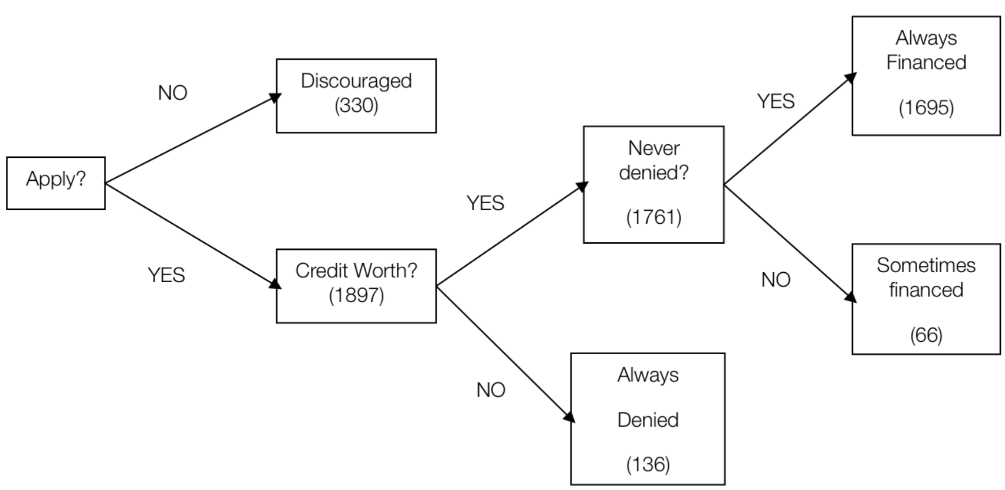

Figure 7: Financing process (Number of observations in parentheses).

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